FACULTY OF TECHNOLOGY

DEVELOPING A PRODUCT PORTFOLIO BUSINESS ANALYSIS FRAMEWORK FOR A CASE COMPANY

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ABSTRACT

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Even though product portfolio management practices have been studied widely in the literature, many organizations still struggle with product portfolio's performance. Product portfolio decisions needs to be made with the goal of improving the product portfolio's performance and following the organization's strategy, but what really needs to be analyzed when doing product portfolio decisions.

This thesis aims to find how product portfolio business analysis should be conducted, find what needs to be considered when doing the analysis and develop new framework for product portfolio business analysis. The thesis is done to a case company with tasks to perform current state analysis to current product portfolio business analysis practices and challenges in the case company and to implement the newly developed framework to one of the units in the case company. The research follows the constructive research method. Current state analysis data is gathered from internal documents and through themed interviews with 13 interviewees from the case company.

The findings of the thesis indicate that case company has problems in product portfolio decisions. Product portfolio decisions are made without real visibility to how those affects to whole portfolio's performance. Based on the findings case company needs more and clearer product portfolio management key performance indicators to be able to see how the product portfolio is performing. In addition to that, product portfolio decisions need more analysis of business model, business ecosystem and portfolio on different levels of portfolio to be able to analyze all of the effects of proposed changes.

Keywords: product portfolio management, product portfolio business analysis, business case analysis

TIIVISTELMÄ

Tuoteportfolion liiketoiminta-analyysiviitekehyksen kehittäminen kohdeyritykselle

Arsi Kähkönen

Oulun yliopisto, Tuotantotalous

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Vaikka tuoteportfolion hallinnan käytäntöjä on tutkittu laajasti kirjallisuudessa, monet organisaatiot kamppailevat silti tuoteportfolion suorituskyvyn kanssa. Tuoteportfoliopäätökset pitää tehdä niin, että tavoitteena on tuoteportfolion suorituskyvyn parantaminen ja organisaation strategian seuraaminen, mutta mitä kaikkea oikeasti pitää analysoida, kun tehdään tuoteportfoliopäätöksiä.

Tämän opinnäytetyön tavoitteena oli löytää miten tuoteportfolion liiketoiminta-analyysi tulisi suorittaa, mitä analyysissä pitää ottaa huomioon, ja kehittää uusi viitekehys tuoteportfolion liiketoiminta-analyysin tekemiseen. Työ tehtiin kohdeyritykselle ja tehtävänä oli suorittaa nykytila-analyysi yrityksen tuoteportfolion liiketoiminta-analyysi käytännöistä ja implementoida osa kehitetystä viitekehyksestä yhteen kohdeyrityksen yksikköön. Työ käyttää konstruktiivista tutkimusmetodia. Nykytila-analyysin data on kerätty yrityksen sisäisistä dokumenteista ja haastatteluista 13 yrityksen edustajan kanssa.

Työn havainnot osoittavat, että kohdeyrityksellä on vaikeuksia tehdä tuoteportfoliopäätöksiä. Tuoteportfoliopäätökset tehdään ilman selkeää kuvaa siitä miten ne vaikuttavat koko tuoteportfolion suorituskykyyn. Havaintojen perusteella kohdeyritys tarvitsee lisää selkeämpiä tuoteportfolion hallinnan keskeisiä suorituskykymittareita nähdäkseen miten tuoteportfolio suoriutuu. Lisäksi, tuoteportfoliopäätökset tarvitsevat lisää analyysiä liiketoimintaekosysteemistä, liiketoimintamallista ja tuoteportfoliosta eri portfolion tasoilla, jotta pystyttäisiin analysoimaan muutosehdotuksien vaikutukset.

Asiasanat: tuoteportfolionhallinta, tuoteportfolion liiketoiminta-analyysi

ACKNOWLEDGEMENTS

This thesis was done in 2021 between February and July for a case company. The aim of the thesis was to improve case company's product portfolio analysis and decision-making processes with product portfolio business analysis framework and implemented product portfolio scenario tool.

I would like to thank the case company and their representatives for this thesis position and interesting and challenging topic. Especially, I would like to thank my supervisors, Mikko and Kari, from case company's side for quiding and helping me troughout the thesis. Also, I would like to thank all of the interviewees and other personel that gave me comments, viewpoints and feedpack during the thesis. Another big thanks goes to my survisors, Harri Haapasalo and Erno Mustonen, from University of Oulu for all of the help and feedback. It has been a pleasure to work with you all.

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ABBREVIATIONS

BCC	Business Case Control
BCG	Boston Consulting Group
CAPEX	Capital Expenditure
COGS	Cost of Goods Sold
ECV	Expected Commercial Value
GE	General Electric
HW	Hardware
IRR	Internal Rate of Return
IIBA	International Institute of Business Analysis
ISACA	Information Systems Audit and Control Association
KPI	Key Performance Indicator
NPD	New Product Development
NPV	Net Present Value
OPEX	Operating Expenses
PI	Productivity Index
PMI	Project Management Institute
PPM	Product Portfolio Management
ROI	Return On Investment
R&D	Research and Development
SW	Software

1 INTRODUCTION

1.1 Study background

Product portfolio management is widely studied subject and concepts of product portfolio and portfolio management sound easy in theory, but Kahn (2012) states that many organizations still struggle with these concepts. Concept of portfolio management could be used in many different areas for managing tasks and decisions made in portfolio management can affect large portion of the organization and their processes (Kahn 2012; Tolonen et al. 2014a). Product portfolio management is analytical decision-making process to existing and new products and these decisions are made to prioritize product and research and development projects (Cooper et al. 2001a; Tolonen 2016). The main tasks of product portfolio management are allocating resources so that the organization could reach the product or technology goals they have set, and ensuring the value, balance, and strategy of the product portfolio (Cooper et al. 1999; Tolonen et al. 2014a).

These portfolio decisions affect directly to product portfolio's performance which is one fundamental thing in product portfolio management (Cooper 1998). According to Tolonen et al. (2015a) product portfolio management targets and key performance indicators are crucial tool to understand and analyze product portfolio's performance. But portfolio's performance is not just one simple figure that can be looked, it is multidimensional concept (Cooper et al. 1998). While product portfolio decisions can affect a big part of the organization, many things can also affect what and how product portfolio decision are made.

Kahn's (2012) definition of portfolio includes two parts, tactical and strategic part. Tactical part means selecting right products and projects and allocating resources to these projects, but the strategic side is more about organizations technology, innovation, and market strategy (Kahn 2012). This side of the portfolio affects product portfolio decisions especially in long term and these aspects can be seen in product development decisions for example in business case process tasks by Cooper & Kleinschmidt (2007) and Kinnunen et al. (2011). Even tough market and technology strategy are considered in business cases, these are not the only factors from the business side that affect to product development (Kinnunen et al. 2013). So, what really needs to be considered when doing

product portfolio decisions and how these decisions should be done to products, product families and product groups over different generations to get the best performance out of the product portfolio as possible?

1.2 Research problem and objectives

This thesis focusses on product portfolio management and business cases and how those can be utilized in product portfolio decisions. The thesis also adds different business analysis viewpoints to these decisions. This thesis is done to a case company which is large international technology company. The case company has complex product portfolio including multiple different hardware, software, and service products which are usually sold as complete solutions with combination of the three product types.

The main objective of the thesis is to develop new theoretical framework for product portfolio business analysis to help make analysis and decision making regarding of the future of the product portfolio. In addition to the theoretical framework, the aim is to implement part of this framework to the case company. The implementation is focusing on product portfolio analysis over product groups and generations with a possibility to create scenarios about the future of the product portfolio. These objectives are formed to three research questions below.

RQ1: How can product portfolio business analysis be conducted and what are the related attributes?

The first research question is focusing on finding how product portfolio business analysis can be conducted and what are the practices according to current literature. It also aims to find out what are the related topic areas and attributes that it is related to. The answer of the first research question also enables the answer for the second research question.

RQ2: What is the current state of product portfolio business analysis in the case company? What are possible challenges?

The second research question takes the studied topics from the literature and asks how these topics are handled currently in the case company. The answer for this question is

answered based on current state analysis which uses case company's internal materials and interviews as a source for the information.

RQ3: How to build product portfolio business analysis framework for decision making?

The third research question is aimed towards the framework. The framework uses answers form first and second research question as a base for the framework. The question is answered in chapter four where the developed product portfolio business analysis framework is presented.

1.3 Research process

The research idea arose from problem in product portfolio decision-making in the case company. This idea and the scope of the thesis was then discussed with key personnel from the case company during the first two weeks. During this time introduction to the topic was done and first material were gathered to help understand the background of the topic. After the topic and scope of the research was settled with the case company, the topic was introduced to the university. Constructive approach was selected for the thesis due to the complex nature of the topic. Research questions were formed to support the structure of the thesis and guide the research towards the desired results.

Literature review in chapter 2 was done to provide foundation for empirical analysis. The literature review included topics around product portfolio management, business cases and business analysis. It also synthesizes the topics from the literature and connects them together to answer the first research questions and to form base for the second research question.

Current state analysis in chapter 3 was conducted after the literature review to answer the second research question. Current state analysis was scoped for one unit of the case company. Material gathering was the first task of the current state analysis. The material for the analysis was from the case company's internal pages and from interviews with case company's employees. Interviewed persons were form many different teams and job responsibilities to get wide and thorough view of the current state in this unit. The current state analysis answers to the second research question by comparing the current product

portfolio management, business case and business analysis practices in the case company to the literature and finding possible challenges that the company has.

Planning of the framework started already during end of literature review when all of the related topic areas were covered. The framework for product portfolio business analysis was created based on relevant theoretical background and current state analysis of the case company and finalized based on comments form case company's and university's representatives. In addition to theoretical framework, part of this framework was implemented as tool for product portfolio analysis. This tool was developed for the unit's product portfolio team and it went through weak market test.

At the end of the research, key results were synthesized, conclusions were drawn, and the research were evaluated and finalized. The research process can be seen below in the figure 1.

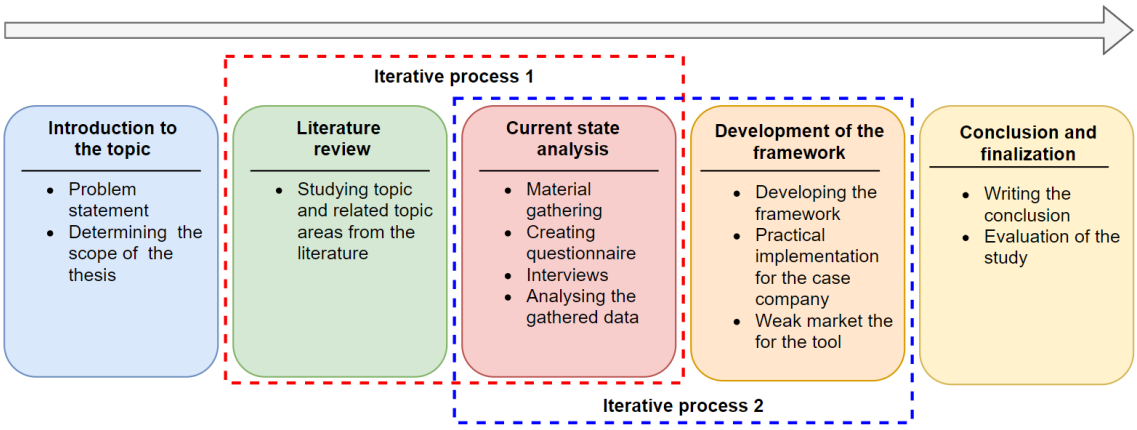

Figure 1. Research process

2 LITERATURE REVIEW

2.1 Product portfolio management

Portfolio management should be easy in conceptual level, but it has not been that easy in many organizations (Kahn 2012). Reason for that according to Khan (2012) is that decisions which are made in portfolio management affect so many other processes in the organizations. Tolonen et al. (2014a) states that portfolio management could be used in many different areas for managing tasks that same resource group performs. The most important objectives of the portfolio management are value, balance, and strategy of the portfolio (Tolonen et al. 2014a). Cooper et al. (1999) states that portfolio management is all about allocating resources of the business to reach the product or technology goals of the organization. But what product or portfolio even means?

2.1.1 Product

Product can be seen from many different perspectives and word product has multiple definition in the literature. One of the perspectives is that product can be hardware, software, service, or combination of those (Kropsu-Vehkapera 2012). Harkonen et al. (2015) describes service product as abstract and intangible. Service products can provide value and satisfy customer need without anything tangible asset (Harkonen et al. 2015).

Other perspective of products is the tangible and intangible products or the combination of these (Haines 2014; Harkonen et al. 2015; Kahn 2012). Software can also be seen as intangible product but in the end, product is suitable combination of those to create the product that satisfy the need of customer (Harkonen et al. 2015). Kahn's (2012) definition of product includes all these perspectives and it is "Term used to describe all goods, services, and knowledge sold. Products are bundles of attributes (features, functions, benefits, and uses) and can be tangible, as in the case of physical goods; intangible, as in the case of those associated with service benefits; or a combination of the two".

Haines (2014) doesn't see product just as a stand-alone item but rather than he sees product as part of other product, product lines, product groups, solutions, and systems. Products are also part of product portfolio and not just serial numbered item (Haines 2014;

Kropsu-Vehkapera 2012). Products can also be made for different customers as business can be business-to-business, business-to-consumer or even business-to-business-to-consumer (Haines 2014).

2.1.2 Product lifecycle

Tolonen et al. (2015b) define product lifecycle phases as new product development (NPD), maintain, warranty and archive. NPD phase is when new products are researched and developed based new or already existing technologies or platforms. Maintain phase includes ramp up, sales, delivery, and ramp down of the product. In this phase new products are not developed anymore, but existing products can have new improved versions. Improvements can happen for example by reducing manufacturing or material cost with new components. Warranty phase includes the spare part business of the product as well as care services. Archive phase is for products that are already obsolete, but law requires to store product data for certain time. (Tolonen et al. 2014b; Tolonen et al. 2015b)

There are also other definitions of product lifecycle phases. Crnkovic et al. (2003) have six phases their definition that are: the business idea of the product, requirements management, development, production, operation and maintenance, and disposal. Stark's (2005) definition includes five phases: imagine, define, realize, support, and retire. Saaksvuori and Immonen (2008) present their lifecycle phases with s-curve of cash flow during different phases (Figure 2). In presentation by Saaksvuori and Immonen (2008), there are six phases. These phases are: Planning, Introduction, Growth, Maturity, Decline and Retirement. From the figure we can see that the cash flow is usually first negative in the first "Planning" phase, but it starts to rise above zero during "Introduction" phase. It grows during "Growth" phase but then it flattens during maturity. Cash flow then declines during "Decline" phase and goes to zero during "Retirement". (Saaksvuori & Immonen 2008)

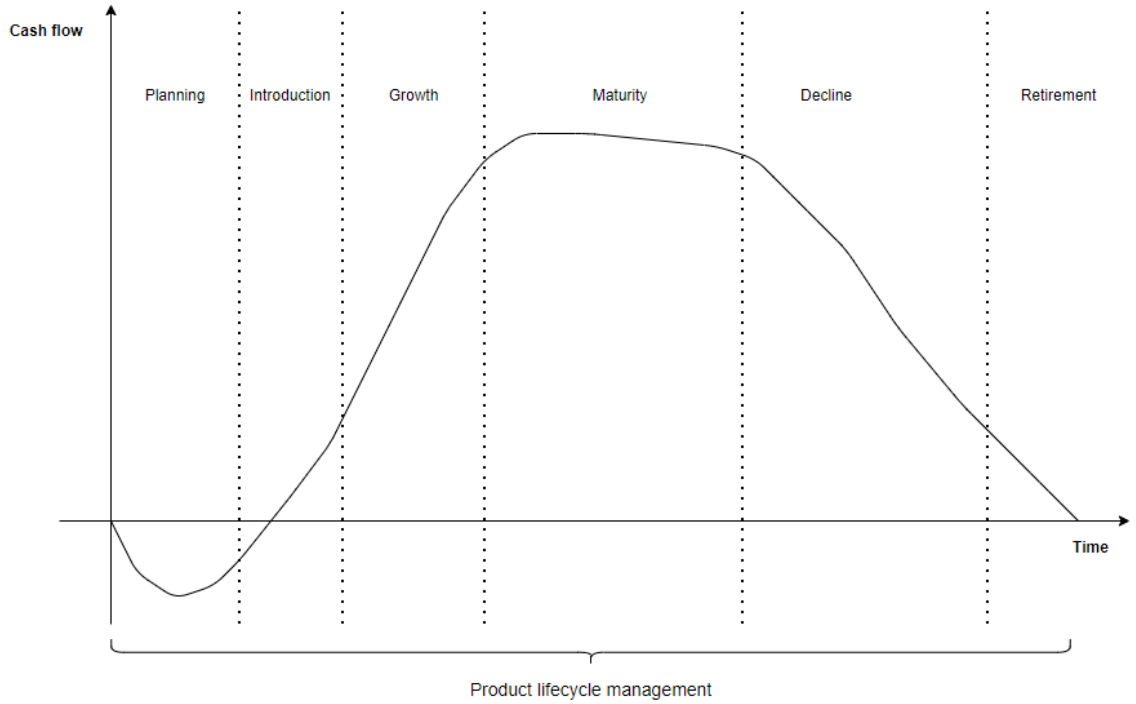

Figure 2. Generic lifecycle model (modified from Saaksvuori & Immonen 2008)

Tolonen et al. (2014b) states that these lifecycle phases can vary a lot from company to company and the size of the company can also have an effect to the number of phases used. Smaller companies could use simplified version of lifecycle phases and larger companies usually have more phases that have more detailed definitions. Whatever the definition is, products should be managed according to the phases they are in. (Tolonen et al. 2014b) Haines (2014) has made product management lifecycle model (Figure 3) where you can see different phases of product's lifecycle. First is "Discovery and Innovation" which includes market insight and strategy. Next is "New Product Planning" where the concept of the product is developed, feasibility is tested, and product definition is created. "New Product Introduction" includes development and launch of the product. "Post-Launch Product Management" is where performance management of products is done. Product are managed during Growth, Maturity and Decline phases. In this model, there are also different decision check points and major decision points. These can be found for example before development and during launch. This lifecycle management

model can be used for single products or even for the whole product portfolio. (Haines 2014)

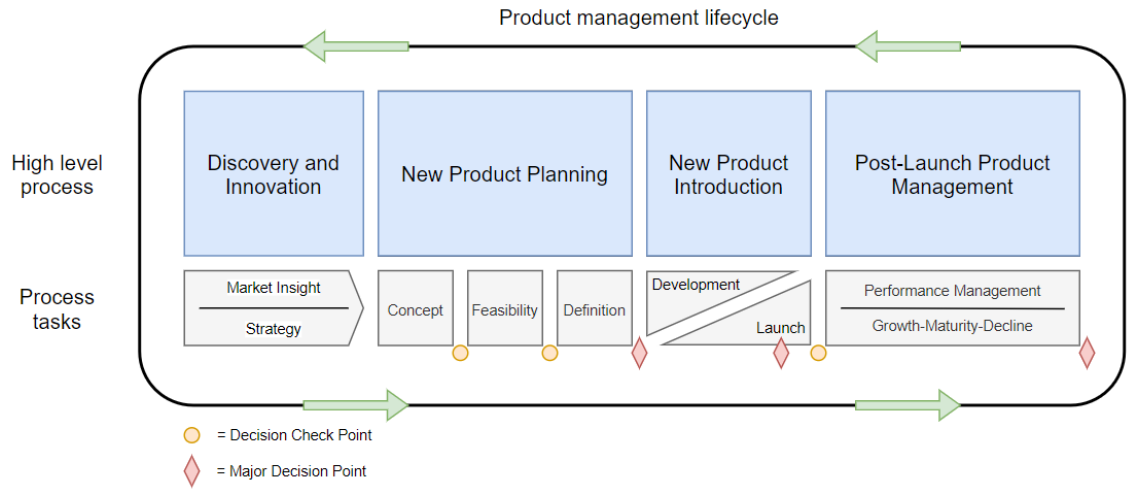

Figure 3. Product Management Lifecycle Model (modified from Haines 2014)

2.1.3 Platform and technology management

Product platform are defined with multiple ways in the literature. Meyer's and Lehner's (1997) definition of product platform is "a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be effectively developed and produced". Other views include for example Levandowski's (2014) view that multiple products could be done from collection of different parts. Robertson and Ulrich (1998) see the product platform as product family that share some set of assets. These assets are components, processes, knowledge, and people and relationships. (Robertson & Ulrich 1998).

Robertson and Ulrich (1998) state that product platform is one important part of product development. With good product platform, organization's product development process will be more efficient and more responsive (Robertson & Ulrich 1998). Procurement costs and manufacturing costs are decreased because many components are shared with multiple products (Meyer & Lehner 1997). As platforms enable mass customization, flexible manufacturing, and integration of new components to platforms, organizations can increase their market share with larger set of products and rapid response to opportunities (Meyer & Lehner 1997; Robertson & Ulrich 1998).

Wortmann and Alblas (2009) note that platform's and product's lifecycles are separate because product platform's lifecycle usually consist more than one product generation. Pedersen (2010) recognize fundamental sequence that is used in most of platform development processes and it consist platform preparation, execution, and maintenance. Preparation includes scoping of the platform and identification of market segments and customer needs which results in platform requirements (Levandowski 2014; Pederson 2009). Platform execution phase includes generation of products and product variants for the platform. Maintenance phase is more about keeping the product platform up to date and updating it based on new requirements from customers. (Levandowski 2014)

Product platform planning includes many different aspects for example direction technology development, target market planning and product introduction timings (Albright 2002; Bowman 2006; Münch et al. 2019). Product platform roadmap is one good document that can summarize the platform plan (Bowman 2006). With roadmaps organization can visualize technology, platform and product development phases, timing of the planned releases and deliveries, development of capabilities, linkages of technology, platforms and products, lifecycles, and investment timings (Bowman 2006). Albright (2002) adds that roadmaps can be used for showing how products serve market needs from different market segments.

Albright (2002) furthermore explains that roadmaps fit to the process after market and competitive strategy shows where organization want to go. Product roadmap then visualizes the offering and technology roadmap shows how the capabilities are developed (Albright 2002; Bowman 2006; Münch et al. 2019). At the end these roadmaps turn in to action plan for the organization (Albright 2002).

As Wortmann and Alblas (2009) suggest that product generations and product platform's lifecycle should be managed and planned, Lenfle et al. (2007) mention that it is not always possible to plan all of the products in that platform. If the industry is dynamic, there is possibility of designing unplanned products in the middle of platform's lifecycle (Lenfle et al. 2007). Platform management itself is closely related to product portfolio management as it evaluates technologies and products to each other (Mikkola & Skjøtt-Larsen 2006). Meyer and Lehner (1997) note that platform management also includes the renewal of the product platforms. Without product platform renewal, products that are

created from the platform will be outdated and the value of platform will decrease (Meyer & Lehner 1997). Sometimes there might be tradeoffs between investment to customer specific innovation and platform generations, but this renewal process should be done in balance with those core products and product platforms (Meyer & Lehner 1997; Wortmann & Alblas 2009).

2.1.4 Definition of product portfolio

Kahn (2012) states that the word portfolio is often misunderstood even though it is widely in use in most organizations. Reason for that could be that it does not have one clear definition. Definition that Kahn (2012) used was that portfolio consist two parts, strategic and tactical part. Strategic part links to organizations innovation, market, and technology strategy. Tactical part is more about selecting right project and allocating funding and resources. (Kahn 2012)

Haines (2014) describes product portfolio as a set that includes all the products that organization has. It includes all the groups like product lines, business units or divisions (Haines 2014). Tolonen (2016) and Jacobs and Swink (2011) all define product portfolio as collection of all products. Haines (2014) continues that, one product line or even one product can also be the whole product portfolio in smaller organizations. We can see Haines's (2014) one example of product portfolio in (Figure 4). In the figure, product portfolio is the top layer, product lines are below that and the last layer is individual products in product line.

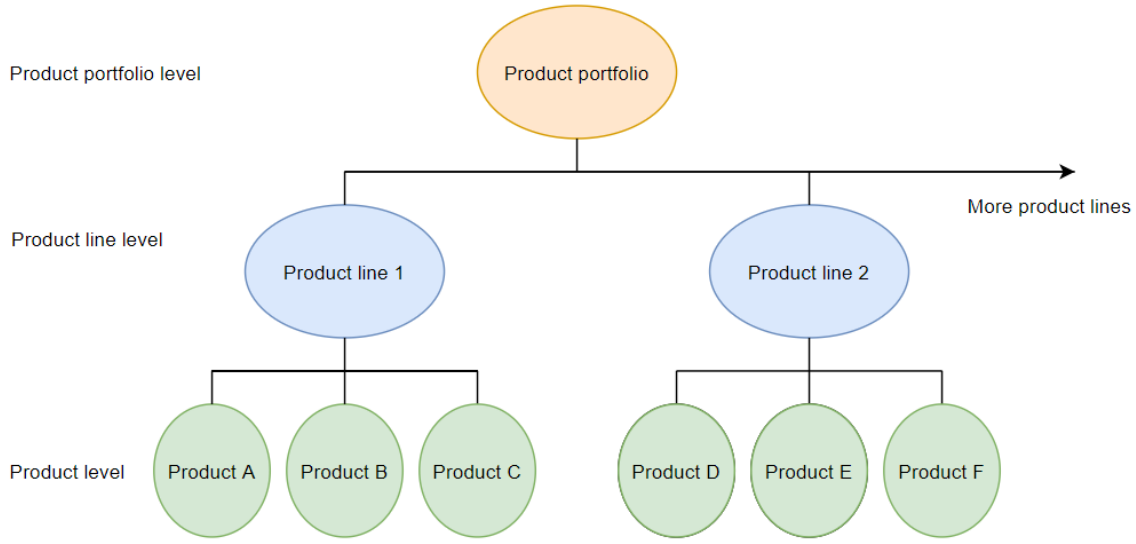

Figure 4. General Product Portfolio Structure (modified from Haines 2014)

Product portfolios can be divided to different groups based on different characteristics. These divisions can be for example, different markets, different product groups, divisions between hardware, software and services, different technologies, customers, or materials (Haines 2014; Tolonen 2016). Product portfolios can be also presented with horizontal or vertical product portfolios like proposed by Tolonen et al. (2015b). Product portfolio includes all of the products from different lifecycle phases, were they in existing products or just in development (Haines 2014). Horizontally product portfolios can be divided to NPD, maintain, warranty and archive portfolios according to different product lifecycle phases (Tolonen et al. 2015b). These phases can be seen in the (Figure 5). Vertically Tolonen et al. (2015b) have divided the product portfolio to seven different layers (Figure 5). These include solution, product family, product configuration, sales item, main assembly, sub-assembly, and component portfolios. This division is done based on product structure layers. (Tolonen et al. 2015b)

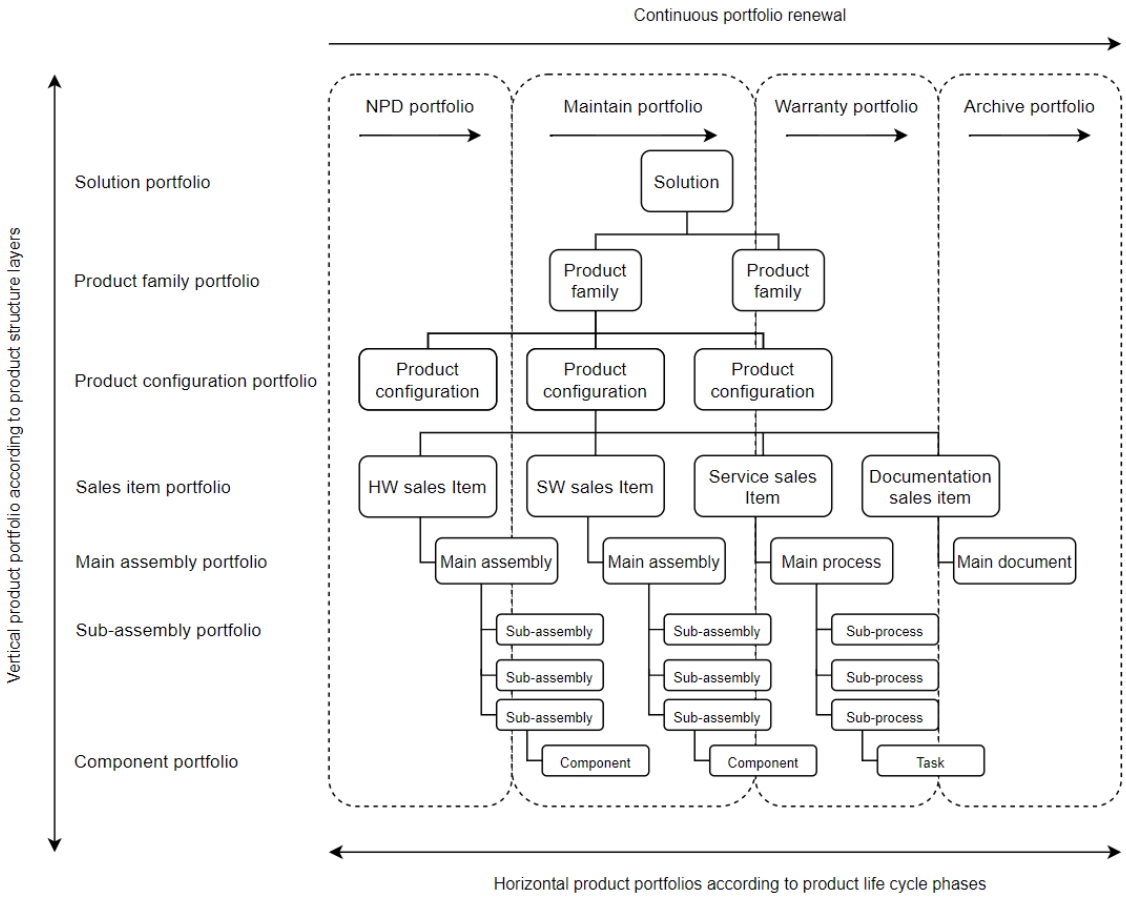

Figure 5. The ontology of proposed horizontal and vertical product portfolios according to lifecycle phases and product structure levels (modified from Tolonen et al. 2015b)

2.1.5 Product portfolio management

Product portfolio management is an analytic decision-making process where products and R&D projects are updated and analyzed. Products are analyzed based on changing uncertainty and opportunities, technologies, strategic goals, markets, and customer needs. This decision process evaluates all products, new and older ones, and prioritizes them. This includes also de-prioritizing and killing of some products if they do not meet the targets. Then resources are allocated based on current prioritization of products and research and development (R&D) projects. (Cooper et al. 2001a; McNally et al. 2009; Tolonen 2016)

According to Tolonen et al. (2014b) the aim of product portfolio management is strategic renewal of the product portfolio which is done cost efficiently. It is also considered to be one of the success factors in product portfolio's performance management (Mustonen et

al. 2020). Strategic renewal can be done by reviewing the portfolio as a whole and comparing products to each other. This allows better understanding of the situation and easier "Go" decisions for new products and "Kill" decision for non-competitive products. (Cooper et al. 2001a; Tolonen et al. 2014b)

Go/Kill decisions and resource allocations are central part of product portfolio management. To be able to do these decisions, organizations needs to have periodical reviews of the product portfolio. Reviews are done holistically by looking the entire product portfolio and reviews ensure that the portfolio is balanced and fulfills strategic and tactical requirements that the organization has set (Haines 2014; Kahn 2012; Tolonen 2016).

Cooper et al. (2001a) states that gating process is closely related to product portfolio management as it is also designed to make Go/Kill decisions and resource allocations. The difference is that gates are used more for individual products, technologies or projects. During gates these products or projects go through in-depth analysis and these gates are placed in multiple points during product development and product lifecycle. Gates and portfolio reviews both help each other with information. Gates provide deeper information and situations of products to portfolio reviews and prioritized products from portfolio reviews help with Go/Kill decisions during gate reviews. (Cooper et al. 2001a; Cooper 2008; Carbonell-Foulquie et al. 2004; Tolonen 2016)

2.2 Product portfolio management targets and key performance indicators

Product portfolio management targets and key performance indicators (KPIs) are crucial part of analyzing and managing product portfolio's performance (Tolonen et al. 2015a). These targets and KPIs also allow better decision making to improve the portfolios performance (Mustonen et al. 2020). Still according to Tolonen et al. (2015a) case study, concept of setting targets and KPIs for product portfolio management was not really known in the case companies. In these case companies, product portfolio management and portfolio performance management were challenging, and performance management included only few KPIs that related to product portfolio management (Tolonen et al. 2015a). Then what targets and KPIs there should be in product portfolio management?

2.2.1 Product portfolio management targets

In Cooper et al. (2001a) study senior management had listed eight reasons why they think that portfolio management is important. These eight reasons included: maximizing financial returns and achieving goals, competitive position, allocating resources efficiently, link between portfolio and strategy, focusing on relevant projects, balancing the product portfolio, communication inside the organization and better project selection (Cooper et al. 2001a). This list of benefits in product managements is good starting point for product portfolio management targets.

Cooper et al. (1997), Tolonen et al. (2015a), Kahn (2012) and Killen et al. (2008) have listed main product portfolio management targets. These targets (Table 1) are: strategic alignment, maximizing the value of the portfolio and balance of projects. Strategic alignment means that the organization's strategic focus can be seen from the portfolio and every project is going towards strategic goals. Idea is that the whole portfolio reflects the organization's strategy and strategy determines the markets, areas and even spending distribution on projects in portfolio. Maximization of portfolio's value means that organization allocates available resources and funding so that the active projects' value is maximized against financial objectives. Success of this can be measured with multiple financial measures like return on investment or net present value. Right balance of projects means that the portfolio is in balance with multiple different parameters. These parameters can be for example markets, long-term versus short-term projects, risk versus reward, high-risk versus low-risk, technology and product lines and types. (Cooper et al. 1997; Kahn 2012; Killen et al. 2008; Tolonen et al. 2015a)

Cooper et al. (1999), Kahn (2012) and Killen et al. (2008) also recognize fourth main target (Table 1), which is right number of projects. This means that organizations limit the number of projects they perform simultaneously so every project fit to organization's capacity. If this limitation is not done, projects can fail or take too long to reach market, because the pipeline is in gridlock and main tasks are not performed. (Kahn 2012; Killen et al. 2008)

Table 1. Main targets of product portfolio management (Cooper et al. 1997; Cooper et al. 1999; Kahn 2012; Killen et al. 2008; Tolonen et al. 2015a)

Target	Short description	Literature references
Strategic alignment	The whole portfolio, every project, reflects the organization's strategy.	Cooper et al. 1997; Kahn 2012; Killen et al. 2008; Tolonen et al. 2015a
Maximizing the value of the portfolio	Allocation of resources to maximize the financial value of all projects.	Cooper et al. 1997; Kahn 2012; Killen et al. 2008; Tolonen et al. 2015a
Balance of projects	Balancing portfolio with different parameters like risk, reward, time, markets, and technology.	Cooper et al. 1997; Kahn 2012; Killen et al. 2008; Tolonen et al. 2015a
Right number of projects	Limiting the number of projects performed simultaneously to fit with resource capacity.	Cooper et al. 1999; Kahn 2012; Killen et al. 2008

2.2.2 Product portfolio management KPIs

Measuring performance of the product portfolio is fundamental thing in product portfolio management according to Cooper et al. (1998), without it you really do not know how well portfolio management is working. Portfolio's performance is not just one number you measure, it is multidimensional concept where you need to measure a lot of things to understand how portfolio is performing (Cooper et al. 1998). In Cooper's et al. (1998) study, they constructed six measures that could tell about portfolio's performance. These metrics were: projects are aligned with business's objectives, portfolio contains very high value projects, spending reflects the business's strategy, projects are done on time, portfolio has good balance of projects and portfolio has right number of projects. (Cooper et al. 1998)

Financial methods are the most used type of methods in portfolio management according to Cooper et al. (2001a) study. Financial methods include many kinds of measures, for example Net Present Value, Expected Commercial Value, Return on Investment, Gross Margin and Cost of Goods Sold (Cooper et al. 1999; Cooper et al. 2001a; Tolonen et al. 2015a).

Strategic methods are second most used type of method in portfolio management according to Cooper et al. (2001a) study. Some strategic portfolio performance measures can be formed as just yes or no questions like: “Is portfolio aligned with strategy?”, “Is spending aligned with strategy?” and “Is product development aligned with strategy?”. These are also some measures with values or ratios like: value of strategic investments for R&D (Target/actual) and number of resources in product development. (Cooper et al. 1997; Cooper et al. 1998; Cooper et al. 1999; Cooper et al. 2001a; Killen et al. 2008; Tolonen et al. 2015a)

Balancing the portfolio is also important part of portfolio management as according to Cooper et al. (1998) study, the top 20 percent performers had clearly better portfolio performance and they really excelled in portfolio balance and right number of projects for available resources. Portfolio’s balance can be measured with number of products, demand of resources versus resources available, balance of long-term and short-term products, balance of high-risk and low-risk projects etc. (Cooper et al. 1997; Cooper et al. 1998; Cooper et al. 1999; Cooper et al. 2001a; Killen et al. 2008; Tolonen et al. 2015a). In table 2 below, product portfolio management KPIs are divided according to different targets.

Table 2 Product portfolio management KPIs divided according to targets (Cooper et al. 1997; Cooper et al. 1998; Cooper et al. 1999; Cooper et al. 2001a; Killen et al. 2008; Tolonen et al. 2015a)

Strategic fit KPIs
• Product portfolio aligned with strategy • Product development aligned with strategy • Number of resources in product development • Spending aligned with strategy • Value of strategic investments for R&D
Value maximization KPIs
• Net Present Value (NPV) • Expected Commercial Value (ECV) • Return On Investment (ROI)

• Internal Rate of Return (IRR) • Number of High-value and return projects • Gross Margin, Net Margin, Net profit • Market attractiveness by product • Size of financial opportunity • Productivity Index (PI) • Cost of Goods sold (COGS) • Projects done on time, No pipeline gridlock
Balance and right size of the portfolio KPIs
• Size of the portfolio, Number of products • Balance of resources: Demand of resources versus resources available • Balance of long-term and short-term projects/products • Balance of high-risk and low-risk projects/products • Balance of technology: Technical feasibility, Technical gap • Balance of markets

2.2.3 PPM targets and KPIs over product lifecycle

Tolonen et al. (2014b) states that new product development phase of product lifecycle is well studied area in portfolio management context, but other lifecycle phases are not that widely studied in this context. If you want to renew the product portfolio effectively, you need to understand that business activities and requirements are different in every product lifecycle phase. This means that product portfolio management targets and KPIs also needs to be adjusted according to different lifecycle phases because of their different nature. (Mustonen et al. 2020; Tolonen et al. 2015a)

Tolonen et al. (2015a) states that New Product Development (NPD) portfolio differs from the rest with more strategic and long-term targets and KPIs. The focus of this phase is in long-term economic sustainability by developing new products and technology (Mustonen et al. 2020). Maintain, Warranty and Archive portfolio are more operational, and these portfolios are more affected with changes from the outside environment, so decision making process is more dynamic. Maintain phase focuses more in product improvements and ramping down unprofitable products. Warranty phase supports

product that are removed from the product portfolio. Archive phase is for storing the product data as long as the law requires. Common target for the whole portfolio is continuous renewal of the portfolio (Figure 6). New product introductions should happen with good balance with product ramp downs. Products need to flow through the horizontal portfolios, so that products do not drop below the targets of the portfolio and explosion of the portfolio is avoided. (Mustonen et al. 2020; Tolonen et al. 2015a)

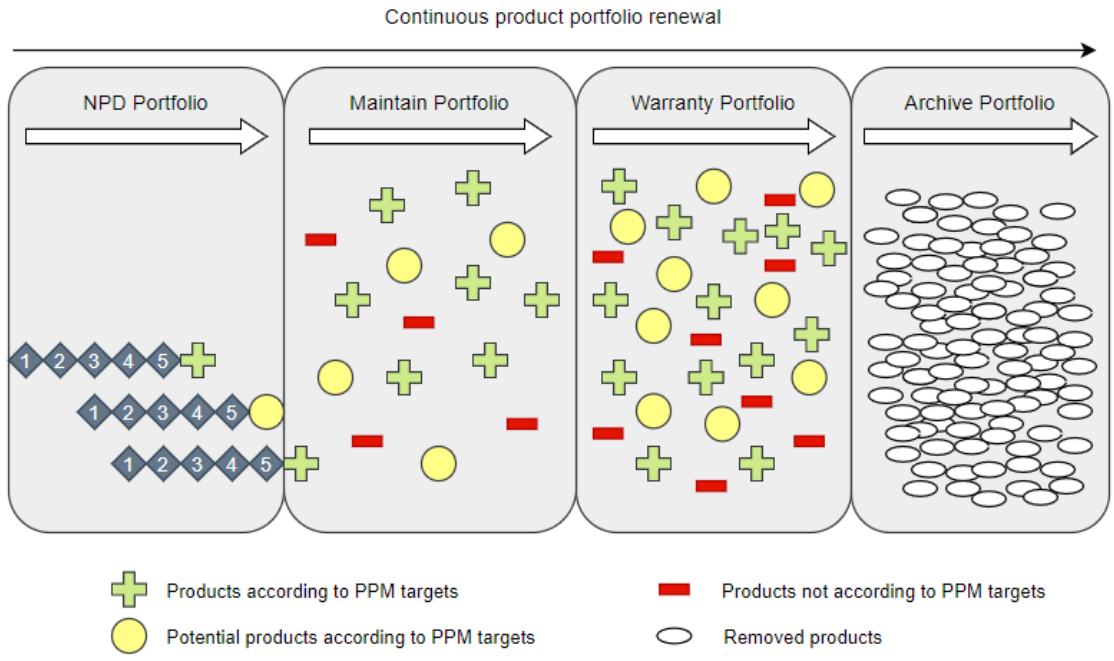

Figure 6. Products in horizontal sub-portfolios (modified from Tolonen et al. 2015a)

Tolonen et al. (2014a) study states that common challenge in their case study companies was growing and too big size of the product portfolio. If product portfolio is too big, product can cannibalize each other and that will affect negatively to product revenue shares and could cause negative product business cases (Mustonen et al. 2020; Tolonen et al. 2014a). Tolonen et al. (2014a) saw that companies lack in product portfolio level business case thinking and this is caused by focusing too much on new product ramp-ups than to the whole product portfolio performance. The lifecycles of products are not planned in the first business case and product portfolio explodes because products are not ramped down in time. (Tolonen et al. 2014a; Tolonen 2016)

2.3 Business case

Business case is a tool that is used to justify project initiation by listing the reasons, benefits and objectives of the project and it can lead to go or no-go decision for the project (Project Management Institute (PMI) 2017). Unfortunately, Information Systems Audit and Control Association (ISACA) (2010) tells that the business case is often seen as necessary evil to get the wanted funding for different projects and almost never looked again after the funding is obtained. Also, Keen (2011) states that one of the roles of business can be "Money magnet" and tell stories how this project is the way to riches. This perspective of the business can sound bad and can definitely cause challenges, but if used correctly and developed with some thought, business case can be one of the most valuable tools for management. (ISACA 2010)

2.3.1 Definition of a business case

ISACA (2010, p. 33) defines business case as; "Documentation of the rationale for making a business investment, used to support a business decision on whether or not to proceed with the investment and as an operational tool to support management of the investment through its full economic life cycle". Keen (2011) states that the business case document is done to help executive decision makers in investment decisions. The document should include benefits to the business, risks, costs, assumptions, evidence etc. (Keen 2011). Kopmann's et al. (2015) contents of business case includes evaluations of risks, time, resources, costs, and benefits. The business case is then used to determine the prioritization of the projects and which projects get the funding and which do not (Kopmann et al. 2015). PMI (2017) describes business case as feasibility study that is used to decision making about the project's future based on the possible benefits that it may result.

PMI (2017) also states that business case is not only used at the start of a project but rather it should be used in all parts of the project. Business case is also a good tool to measure the success of the project after the project is done. Business case has a lot of different assumptions and objectives that can be compared to result of the project. (ISACA 2010; PMI 2017)

2.3.2 Business case content

As ISACA (2010) and PMI (2017) both state that business case is not just a one-time thing made for funding's sake, but rather than tool to be used throughout the whole project. But to be able to do that, the business case content must be filled with accurate, relevant, and most recent data possible and it should answer to the most relevant questions about the project (ISACA 2010).

The first thing that business case should contain is the introduction (Schmidt 2009). This part should tell everybody that what this business case is about. It should answer the question: "What we are doing?" so, everybody knows the subject of the business case. (ISACA 2010; Schmidt 2009) The introduction should include the problem or the opportunity behind the business case, so that the purpose "Why we are doing it?" is clear (PMI 2017; Schmidt 2009). Also scope of the business case should come up from the introduction. It should tell who the stakeholders of the project are and how they contribute to the project. (ISACA 2010; Keen 2011; PMI 2017; Schmidt 2009) The desired output and business benefits and value should be also one part of the introduction (ISACA 2010).

The business case introduction is the first overview of the potential project, but more detailed plans and analysis needs to be done. Keen (2011) has divided his business case creation process to three part, where "Define" is the first part. The first step of the "Define" part is the scoping, which includes building the team and setting the schedule (Keen 2011). These parts should be included in the project plan in addition with other resources, for example money and equipment, and roles and responsibilities of the participants. Business case analysis should also include work effort estimation, analysis about the business, operational and technical capabilities, and different assumptions. (ISACA 2010; Keen 2011; Kinnunen et al. 2011; Kinnunen et al. 2014; Schmidt 2009) Lastly, business case should have milestones, which are aligned with the goals and plans of the organization (ISACA 2010; PMI 2017).

Like already said in definitions, business cases are used to make decisions about ideas, problems, and opportunities and if they are worth the project and the investment (ISACA 2010; Keen 2011; Kopmann et al. 2015; PMI 2017). Big part of that decision is the business impact that the project would have. That is why different calculations and analysis are needed to determine the possible benefits, profits, and other positive

outcomes, for example market attractiveness and competitive advantage, that the project could have. From the other side, cost, risk, and sensitivity analysis are also very important, so the decision makers would have all possible positive and negative effects that the project could bring. (ISACA 2010; Kinnunen et al. 2011; Kinnunen et al. 2014; Schmidt 2009)

With all of these calculations and analyzes the decisions are easier to make, but like Keen (2011) mentioned, all of these claims that are made with calculations and analyzes have to be believable. If the claims are not provable, nobody will believe them (Keen 2011). One way of increasing the credibility of the calculations and analyzes could be creation of different scenarios how the situation could progress, which was listed by Schmidt (2009) as one of the business case's parts. After all this analyzing, calculating, and proving, it is time for conclusion and recommendations. Even though it might seem clear that everybody expects that the author of the business case wants that the investment is made and project is started, business case still should have good conclusion and recommendations that are tied to the analyzed scenarios and business objectives of the organization. (Schmidt 2009)

2.3.3 Business case creation and process

When organization has multiple different opportunities, problems or any other kind of ideas that they would like to develop further, they need to decide which ideas to choose, because usually organizations have more ideas than they have resources to develop those ideas (Kinnunen et al. 2011). This is the part where business case is needed, because with business case of the idea you can justify the further development and compare the existing ideas better (Einhorn et al. 2019; Marnewick & Einhorn 2019).

Using the business case as a tool can be very beneficial, but it is used too many times just to get the funding for the project (ISACA 2010). The funding decision should not be the last time business case is used during the project. Business case should be updated continuously during the lifecycle of the project. By doing this, organization allows better visibility and understanding of the current situation of the project. Decision are easier to make, if the benefits, costs, and risks are really understood by the stakeholders. By going business case reviews, organization can make informed decisions and optimize the project better during its lifecycle. (Einhorn et al. 2019; ISACA 2010)

Marnewick and Einhorn (2019) state that, if you want to get all the benefits from business case, you need to follow a process for creation and follow-up of the business case. If business case is created and followed with good process, it will have very big impact to created value of the investment and how it can be sustained (Einhorn et al. 2019; ISACA 2010). One business case process (Figure 7) is created by Marnewick and Einhorn (2019) and it presents, how business case process could progress through different phases and process groups in IT projects. Business case analysis process is presented more in depth in chapter 2.4.3.

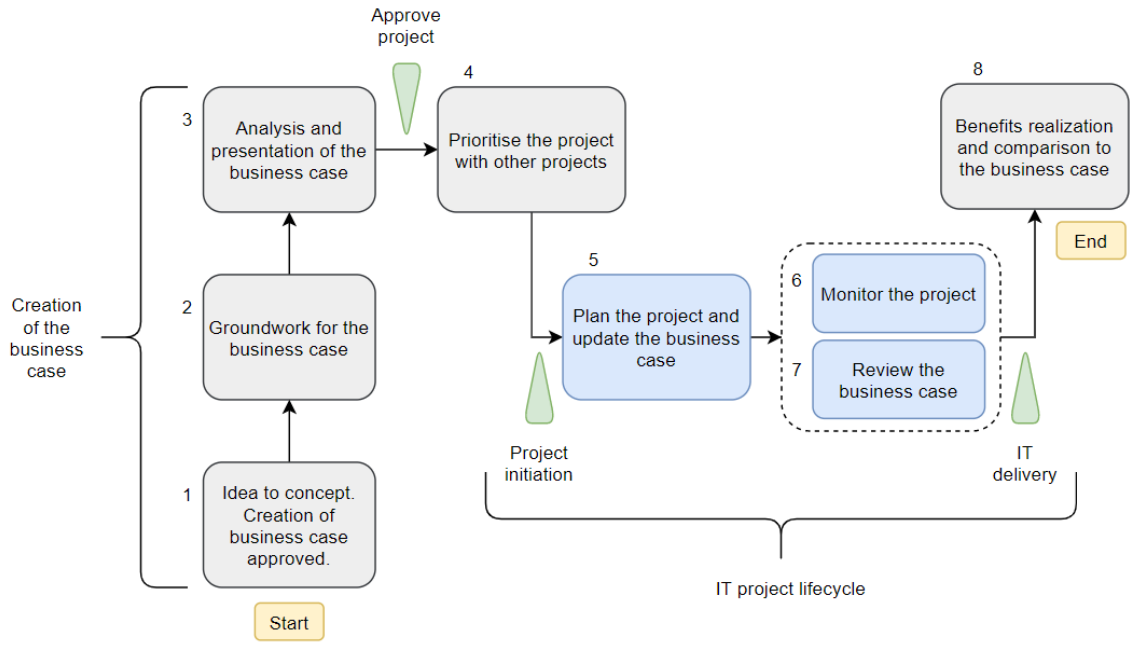

Figure 7. Business case process groups mapped to the IT project lifecycle (modified from Marnewick & Einhorn 2019)

Process groups 1-3 (Figure 7) are usually done before the project starts and those groups are for creating the business case. Process group 4 is for prioritization of the projects and process groups 5-8 are done after the project is started. (Marnewick & Einhorn 2019) These process groups are described in Marnewick and Einhorn (2019) article and in Einhorn et al. (2020) article. The following process group descriptions are formed from those articles: (Einhorn et al. 2020; Marnewick & Einhorn 2019)

1. Process group 1 is for the first preparation of the business case. The base information for the business case is collected and the first proposal of the project is made. The project proposal is evaluated. Decision is made if the proposal will be made into more detailed business case or will the proposal be rejected and archived.
2. Process group 2 includes more detailed information gathering and investigation about requirements from different stakeholders. Estimations are done for possible benefits, costs, and risk of the project. Best approach for the project is determined and the scope is defined.
3. In process group 3, quality assurance and further analysis of financial benefits and risks and are done. The business case is put together for presentation and presented to the decision makers of the project. Decision makers will decide if they will reject, change, or approve the business case.
4. In process group 4, the approved project is compared with other projects that are new or already underway. Start and the schedule for the project will be determined with prioritization of available resources.
5. Process group 5 starts after the project is started. When the projects plan is formed and updated, the business case is one input for that. If the plan of the project changes, the business case needs to be updated according to the plan and checked if the projects business case is still viable.
6. Next process groups 6 and 7 are done simultaneously. Process group 6 includes basic follow-up of the project's key metrics, costs, risks, schedule, and scope.
7. In process group 7, reviews of the business case are done. These reviews are done periodically, but ad hoc reviews can be done if stakeholders want to address concerns. If there are any changes, the business case should be updated and checked, if it is still viable.
8. Process group 8 covers the final assessment of the business case. The business case is compared to the actual results. If results fall short, necessary actions are taken. Learnings of the project are documented.

Kopmann et al. (2015) propose concept of business case control (BCC) which uses business cases for evaluating, monitoring, and tracking projects in project portfolio level. The first element of their proposal includes evaluation and prioritization of project proposals which is done in early stage of project lifecycle when resources are allocated.

The second element includes continuous monitoring of the project's performance and projections. Monitoring of the project's business case starts are projects launch and ends just when the project itself ends. Monitoring the business cases during the project allows quicker reaction for changes and more options for project portfolio decision making if something changes. Tracking of the business case means tracking the business performance and benefits after the project is completed. This is usually done with post-project reviews and it helps the organization to learn and share those learnings to other parts of the organization. (Kopmann et al. 2015)

2.4 Business analysis

International Institute of Business Analysis (IIBA) (2009) describes business analysis as a method for comprehending the structure, policies, and operations of the organization. This analysis is done in cooperation with stakeholders and the goal is to find solutions that move the organizations towards it goals (Carkenord 2009; IIBA 2009). Business analysis involves problem and opportunity identification, identification of capabilities needed for providing products and services, cooperation with stakeholders, management of requirements and products, and definition of organization's goals (Carkenord 2009; IIBA 2009). As in Hart et al. (2003) study, business analysis can also be used as one part of new product development process.

2.4.1 Business ecosystem analysis

Development of new products can be risky and inefficient process, that's why new product development is often done in collaboration with other organizations to share the risks and to increase the efficiency of the process (Bhaskaran & Krishnan 2009; Kinnunen et al. 2013). Carbone (2009) states that some new opportunities also require so diverse set of capabilities to carry out the development and reach to the level of customer needs, that is not possible for just one organization. Iansiti and Levien (2004a) add that some new product development activities need larger number of stakeholders globally. This can mean that entire business ecosystem is responsible for the success of the product development (Kinnunen 2016; Iansiti & Levien 2004a).

Business ecosystem can be described as a network where actors of the network work around core technology of the ecosystem (Den Hartigh & van Asseldonk 2004). Moore (1993) describes these actors as organization that cooperate and develop capabilities inside of the ecosystem, so that they could produce better innovations that satisfy customer needs. In business ecosystem, knowledge, technologies, and resources would be shared within the ecosystem to enable creation of value (Hearn & Pace 2006).

The benefit of business ecosystem for product development is that when cost and resources are shared, risk tolerance is much higher and with availability of multiple organization's capabilities, product possibilities increase (Kinnunen et al. 2013). Iansiti and Levien (2004b) point that increase in productivity can be achieved with lower costs and it is sign of healthy ecosystem. The other side of improved product development is that, sometimes the product development can result in a product that changes the whole business ecosystem. This can mean new partners or business model change for the stakeholders. (Kinnunen et al. 2013)

Kinnunen et al. (2013) have created theoretical view of business ecosystem based on business models of actors (Figure 8). This view shows how firms are connected to each other with their business models and create the business ecosystem. The connections between firms are characterized by offerings and revenue. The value creation structure of the ecosystem is described by the connections between the firms and it can be viewed as a chain or network, but most of the time it is both of those. (Kinnunen et al. 2013; Iansiti & Levien 2004a)

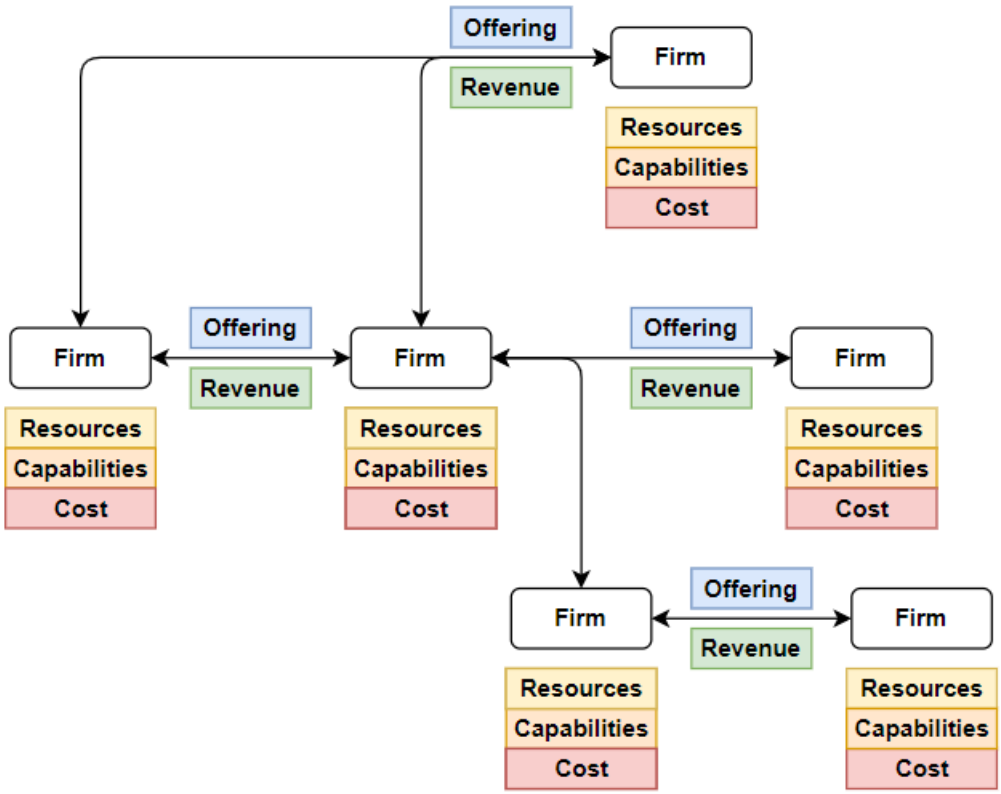

Figure 8. Business ecosystem (modified from Kinnunen et al. 2013)

2.4.2 Business model analysis

Business model can be seen from many perspectives. It can be a strategy analysis and implementation approach and tool to communicate strategic choices (Shafer et al. 2005). It can be an architecture of the revenue (Chesbrough & Rosenbloom 2002). But generally business model is seen as a description how the organization can create and capture value (Chesbrough & Rosenbloom 2002; Haaker et al. 2006; Shafer et al. 2005). This description can include offering, revenue model and the value chain (Suikki et al. 2006)

Shafer et al. (2005) notes that the creation and capturing of value is one of the business fundamentals and business model is representation of the current situation. The value creation is targeted to customers and stakeholders and it refer to organization's use of assets, processes, and activities to create this value. The capturing of value in the other hand then refers to the way organizations make money. This include increasing the competitive advantages and getting the financial returns of the created value. (Ritala et al. 2013, Shafer et al. 2005)

The business model is formed from main actors and elements. The main actors in Kinnunen et al. (2013) business model framework (Figure 9) are the firm and customers. The cooperator seen in the framework can be supplier, partner, or some other part of the value network. Value creation structure is defined by the connections between these actors. Other elements in the model are offering, revenue, resources, capabilities, and cost. (Kinnunen 2013; Kinnunen et al. 2013)

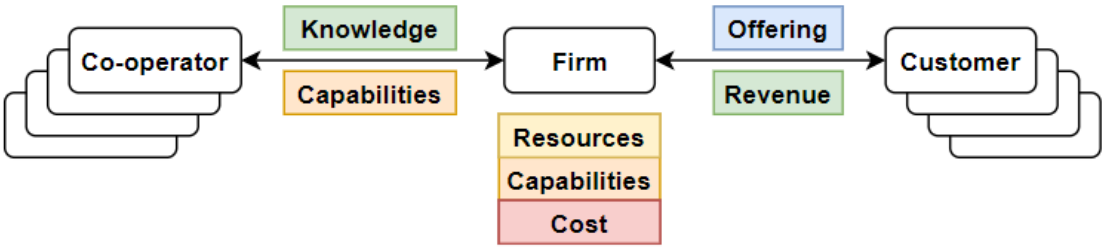

Figure 9. Business model elements and the main actors (modified from Kinnunen et al. 2013)

Creation of products is a collaborative process and can include problem solving for different stakeholders (Kinnunen 2016). Kinnunen et al. (2013) framework could help to understand different roles of stakeholders and create new opportunities. When organization creates new innovations it sometimes can utilize their current business model, but sometime current business model can limit the value capturing possibilities (Chesbrough & Rosenbloom 2002). Some of the opportunities can also change the business model of the firm or the stakeholders and organizations must find the new business model for that situation (Chesbrough & Rosenbloom 2002; Kinnunen 2016; Kinnunen et al. 2013).

2.4.3 Business case analysis

New product development (NPD) is one critical process that needs to work if organization really want to succeed. When organizations generate new product ideas, they need to decide which are good enough for further development. Problem with this is too often, that new ideas are not assessed properly and the move to development phase is done without enough thought and this can cause big problems in the future. To solve this problem, new product development processes usually have few phases for screening the

ideas before organization decide if they want to go to development. Before development, organizations need to know which ideas have the best business potential and this is the part where business case comes into picture. (Cooper & Kleinschmidt 2007; Kinnunen et al. 2011; Kinnunen et al. 2014)

Big innovative organizations can have large amount of new product ideas and these ideas need to be analyzed, evaluated, and prioritized before decision making. Organization can use business cases to perform deeper analysis of the products' business potential. This will help the screening of the product ideas and decision making, so organizations can decide which product are worth of the investment and should go to development phase. (Kinnunen et al. 2011)

Cooper and Kleinschmidt (2007) state that business case is mandatory part of projects lifecycle before it can move to the development phase. Therefore, business cases are created in early stage of new product development (Cooper 2001b; Kinnunen et al. 2014). Cooper (2001b) presents a Stage-Gate® process that describes process from idea discovery until launch and post-launch review. This process is shown in figure 10 below. Stage-Gate® is conceptual model for new product projects, which consist five stages. These stages are scoping, build business case, development, testing & validation, and launch. Stages are where the project team is gathering information, investigating, and analyzing the product project. Build business case stage is second stage in this process and it is done just before the decision if the product project will move to development. Before every stage there is a gate, which are decisions points for the project team, should they continue to invest in the project and proceed to next stage or should they kill the project. These gates are idea screen, second screen, go to development, go to testing and do to launch. First gate is after the idea discovery and before the first stage "Scoping". (Cooper 2001b; Cooper 2008)

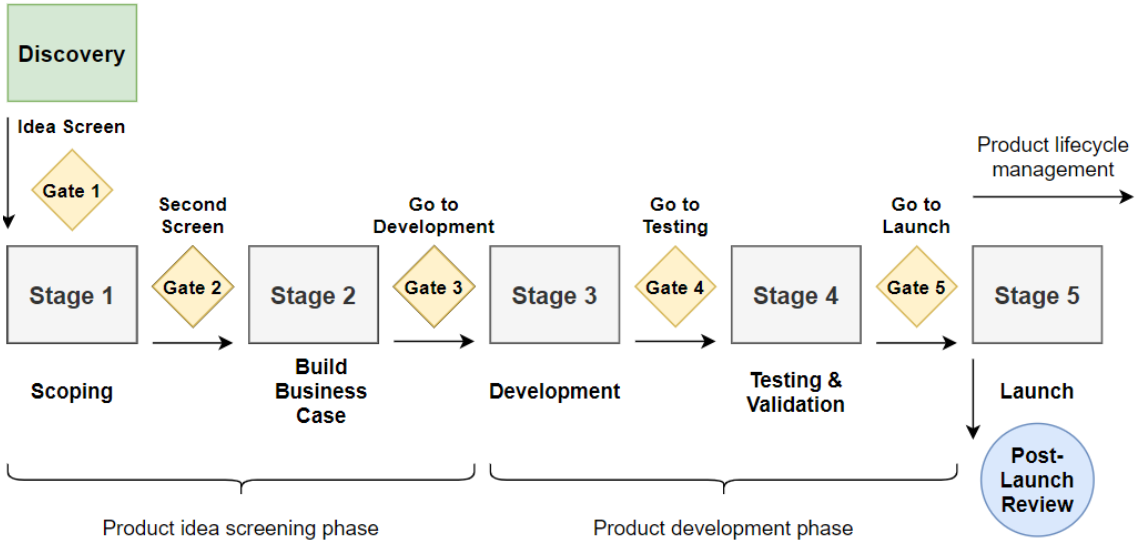

Figure 10. Stage-Gate® process (modified from Cooper 2001b; Cooper 2008)

Cooper (2001b) divides business case to three main components. These components are:

1. Product and project definition: This part will tell what the concept of the product is going to be with features, attributes, benefits, requirements and which is the target market and project scope for the product.
2. Product justification: In this part, business case is justifying why organization should invest into this product. This is done with strategic, competitive, risk and market analyses.
3. Project plan: Plan will tell how the organization plans to develop and launch the product including schedules and required resources.

Cooper (2001b) also mapped the key actions for building the business case (Figure 11). These actions start from market analysis, competitive analysis and user need and wants study which are used to create customer wish list and product requirements. Then detailed technical assessment contributes information to manufacturing costs and production equipment and technical feasibility study contributes to concept testing and then to expected sales and revenue. Concept testing is also the base information to product definition part of the business case. Expected sales and manufacturing costs of the project are the base information to financial analysis which affects to project plan with market and technical assessments. Financial analysis also provides project justification including financial benefits and risks. (Cooper 2001b)

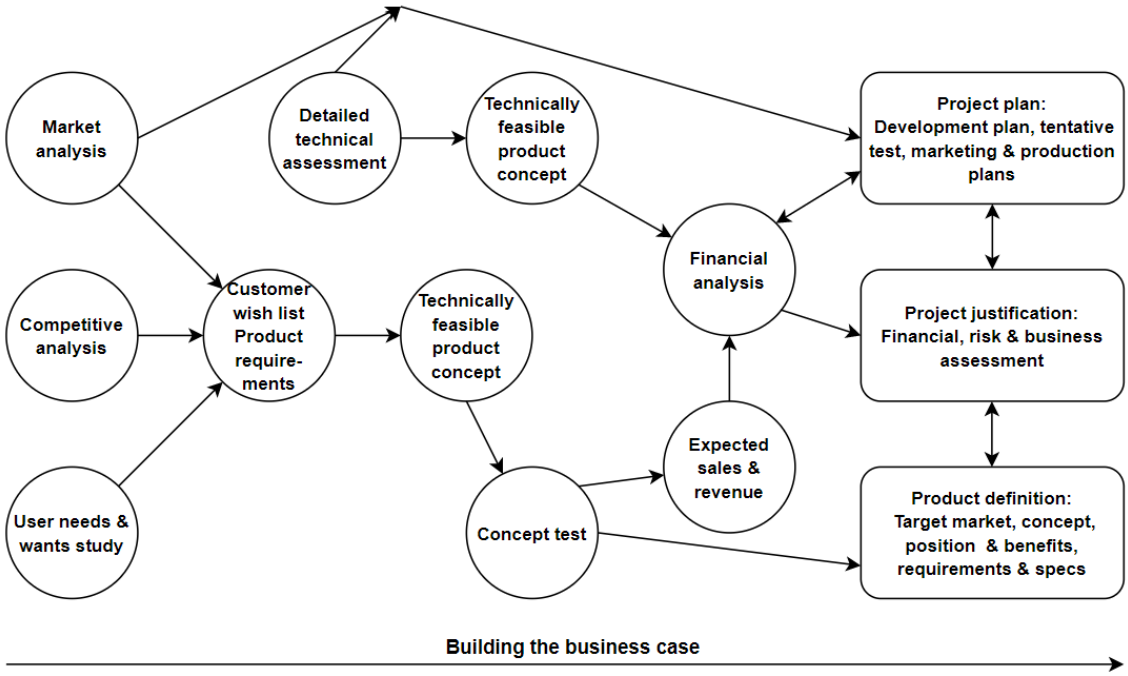

Figure 11. The key blocks in stage 2: Building the business case (modified from Cooper 2001b)

Cooper's (2001b) product justification includes most of the up-front homework that is mentioned in Cooper's and Kleinschmidt's (2007) article. They list five action that result in business case including preliminary market assessment, preliminary, technical assessment, detailed market assessment, detailed technical assessment, and financial and business analysis (Cooper & Kleinschmidt 2007). Koen et al. (2001) also list analysis areas of business case, which include estimated market potential, customers' needs, investment requirements, unknown technology, and risk of the project. Kinnunen et al. (2011) divide these business case attributes to three main categories which are: market assessment, technical assessment, and financial analysis. In addition to these, strategic fit is fourth category in this list, because it is important dimension that can link product proposals to organizations strategy (Kinnunen et al. 2011). List of all the attributes listed by Kinnunen et al. (2011) can be found in table 3 below including additional attributes from other references.

Table 3. Business case attributes (Cooper & Kleinschmidt 2007; Kinnunen et al. 2011; Koen et al. 2001)

Associated element	Business case attributes
Market assessment	Customer need, need level, customer benefits, customer value, customer requirements, opportunity window, target market, total market size, market growth, market potential, and intensity and extent of competition
Technical assessment	Technical complexity, technical uncertainty and risk, availability of resources, technical synergies, work effort estimation, patent position, manufacturability, timing
Financial analysis	Price estimation, Sales estimates: direct sales, additional sales, impact on sales; Cost estimates: development cost, production cost, other lifecycle costs; payback level, cash flow statement
Strategic fit	Fitness to product strategy, fitness to technology strategy

Kinnunen et al. (2011) present business case procedure (Figure 12) as a guide for building a business case. This procedure can of course vary on depth of the analysis and prioritization of tasks in different business environments. In this procedure, market assessment contains defining value and defining market tasks. These tasks can be done independently and parallel with assessment of technical feasibility. Financial assessment needs information from technical and market assessments and therefore needs to be done after those parts. The business case procedure also suggests that strategic fit of the product and technology could be considered before moving to financial analysis. (Kinnunen et al. 2011)

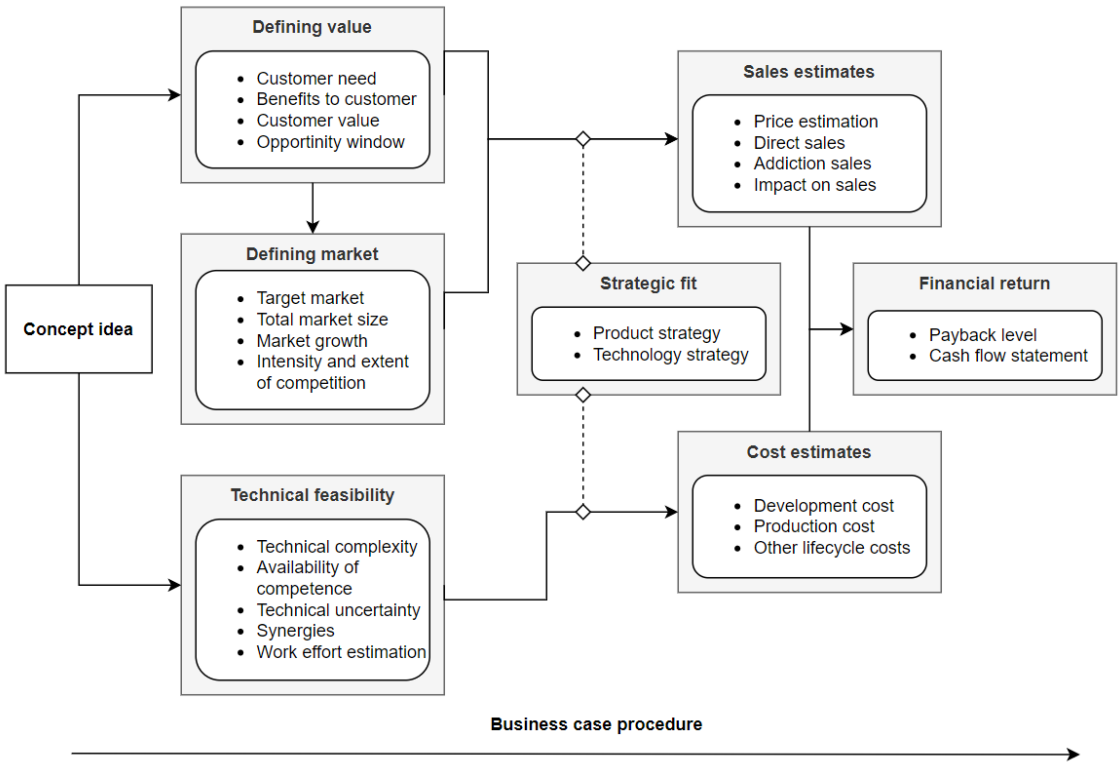

Figure 12. Business case procedure (modified from Kinnunen et al. 2011)

Market assessment is divided to two part as mentioned earlier. The first part of Kinnunen's et al. (2011) business case procedure, "Defining value", includes customer needs, customer benefits, customer value and opportunity window. The second part, "Defining market", includes target market, total market size, market growth and intensity and extend of the competition (Kinnunen et al. 2011¸ Lilien et al. 2002; Loutfy and Belkhir 2001).

In technical assessment, feasibility of the possible new product is assessed from technology and competence side (Kinnunen et al. 2011). This part includes assessment of technical complexity and uncertainty, so that the organizations can evaluate how hard and risky development of the new technology can be. Next task is assessment of organization's own and their partners competences of developing this technology. Technical assessment includes also search for synergies from e.g. existing resources or manufacturing capabilities and work effort estimation. (Carbonell-Foulquie et al. 2004; Kinnunen et al. 2011; Loutfy & Belkhir 2001)

Even tough, product idea would be feasible to develop from technical standpoint and market assessment shows good indications from customers' and market's side, development of the product should also be considered from strategic point of view (Carbonell-Foulquie et al. 2004; Cooper 2008; Kinnunen et al. 2011; Lilien et al. 2002). Products should support strategic product and technology goals of the organization, but every organization should define the strategic fit by themselves. Cooper (2008) lists projects importance to the strategy and alignment with strategy also as factors in decision making before "go to development" decision is made.

In Kinnunen et al. (2011) procedure, financial analysis uses information from both technical and market assessments and in the end estimates the financial returns that the new product could bring. Before financial returns, sales estimates, including price estimated, direct and additional sales and impact on sales of other products, are done based on information from market assessment (Carbonell-Foulquie et al. 2004; Kinnunen et al. 2011, Lilien et al. 2002). Cost estimates then are based on information from technical assessment and include development, production, and other lifecycle costs (Kinnunen et al. 2011). At the end financial returns are calculated after sales and cost estimates have been done and could include for example calculations and estimation of net present value, estimated commercial value, payback level and cash flow. (Cooper 2008; Kinnunen et al. 2011)

Saaksvuori and Immonen (2008) add lifecycle view on product business cases. They state that product's business case should be planned to account every lifecycle phase of the product to avoid mistakes in strategy. Different product lifecycle should include different performance measures and targets for product's business cases. Below is (Figure 13) Saaksvuori and Immonen (2008) presentation of three different business case lifecycle performance scenarios. The first scenario shows the "normal" lifecycle performance of business case that is planned. The second business case performance scenario shows growing sales and potential for the future. In this situation, product should have continued support and if possible, it could be developed further to reach its full potential. The third scenario presents poorly performing business case. This business case shows no potential for the future and it should be killed. Fourth scenario shows how product improvement could increase the lifecycle performance. (Saaksvuori & Immonen 2008)

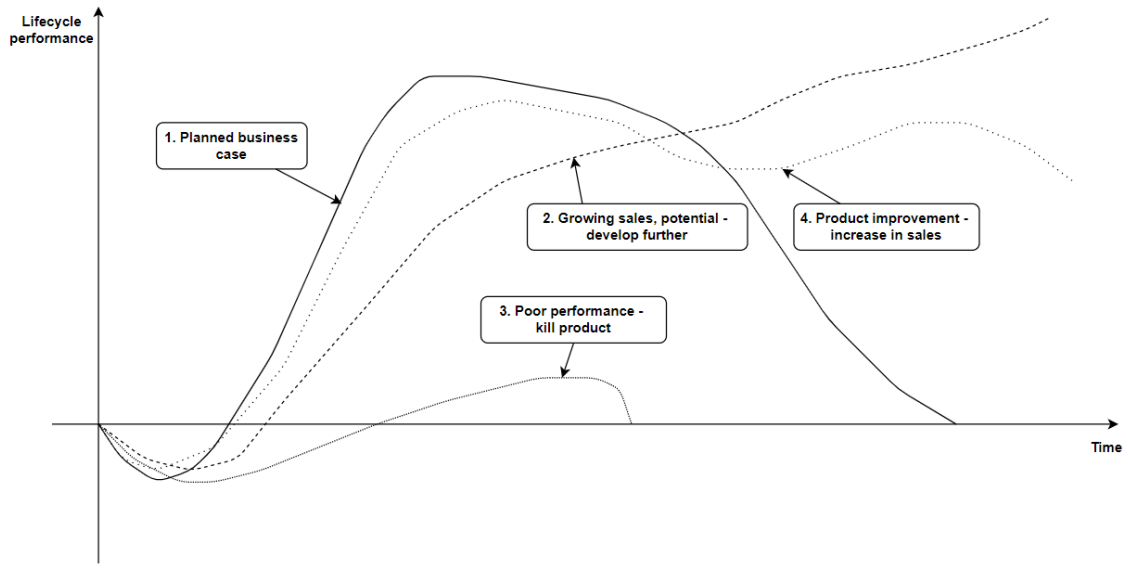

Figure 13 Possible business case lifecycle performance scenarios (modified from Saaksvuori & Immonen 2008)

2.4.4 Portfolio analysis

Portfolio analysis can be viewed from two perspectives and those are product and business (Udo-Imeh et al. 2012). Armstrong and Brodie (1994) view portfolio analysis with portfolio planning methods and note that portfolio planning methods are old tool for strategic decision. These methods help to position products in matrix with two characteristics: attractiveness of the market and products ability to compete in that market (Armstrong & Brodie 1994). Udo-Imeh et al. (2012) lists five portfolio analysis models which are: Boston Consulting Group growth-share matrix, General Electric industry-attractiveness matrix, Shell directional policy matrix, Arthur D. Little strategic condition matrix, and Abell and Hammond investment opportunity matrix.

Mohajan (2017) mentions that Boston Consulting Group's Growth Share matrix (Figure 14) is most well-known and simple matrix for portfolio planning. This matrix can be used for balancing products between four categories which are: stars, cash cows, dogs, and question marks (Armstrong & Brodie 1994; Hambrick et a. 1982; Hendley 1977; Mohajan 2017; Udo-Imeh et al. 2012) Stars have high growth and high market share, so they are business leaders in their area and bring lot of cash to the company but need lot of cash also to support the growth rate (Hedley 1977; Mohajan 2017). Cash cows also generate a lot of cash, but they require almost no investments, so cash cows' profit

margins are excellent. Dogs are opposite of stars. They have low market share and low growth rate. These products lack business strategy and should be avoided or at least minimized in portfolio. Question marks are products with high growth rate but low market share. These products would need more marketing or development investments to grow the market share, but organization do not know do they reach star level of fall to dogs in the end. (Hedley 1977; Mohajan 2017)

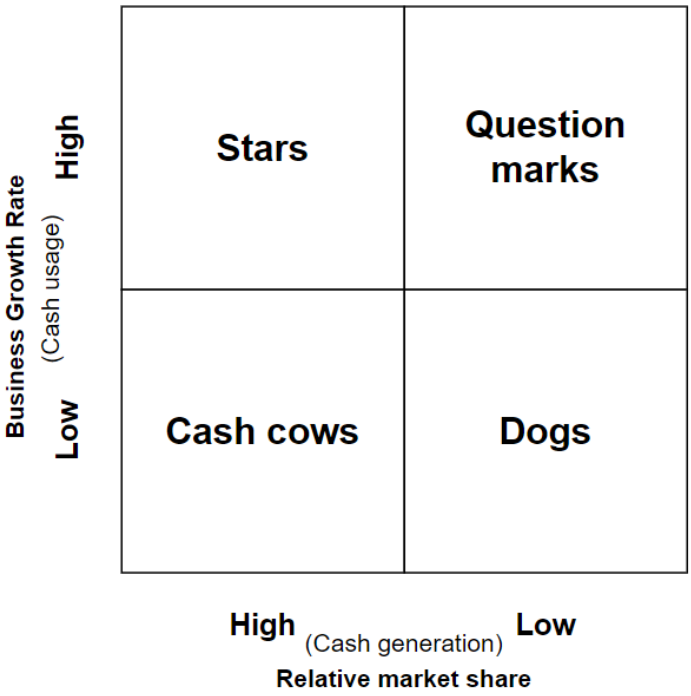

Figure 14. Growth-Share matrix (modified from Hendley 1977)

With portfolio analysis like growth share matrix, organization can improve their portfolio strategy. Of course, goal number one should be, maintain the market position of cash cows and use the cash to help sustain stars positions as well because those cannot sustain it by themselves (Hendley 1977). These matrixes can be also used to analyze business unit's performance instead of only products (Udo-Imeh et al. 2012).

Proctor & Hassard (1990) state that General Electric industry-attractiveness matrix, or McKinsey matrix, is more complex tool than the BCG growth-share matrix. While being more complex, it also provides a nine-cell grid, so it is more flexible product portfolio analysis tool (Proctor & Hassard 1990). This nine-cell grid maps business units with

industry/market attractiveness and business strength (Mokaya et al. 2012; Proctor & Hassard 1990; Udo-Imeh et al. 2012).

McKinsey matrix nine-cell grid can be divided to three categories: grow, hold and harvest (Mokaya et al. 2012; Udo-Imeh et al. 2012). This means that the three most top left cells (Figure 15) have the best potential, and these should be grown. The three most bottom right cells are cells with the least potential. These should be harvested, and exit should be considered. The three cells in between form the hold category. (Mokaya et al. 2012; Udo-Imeh et al. 2012)

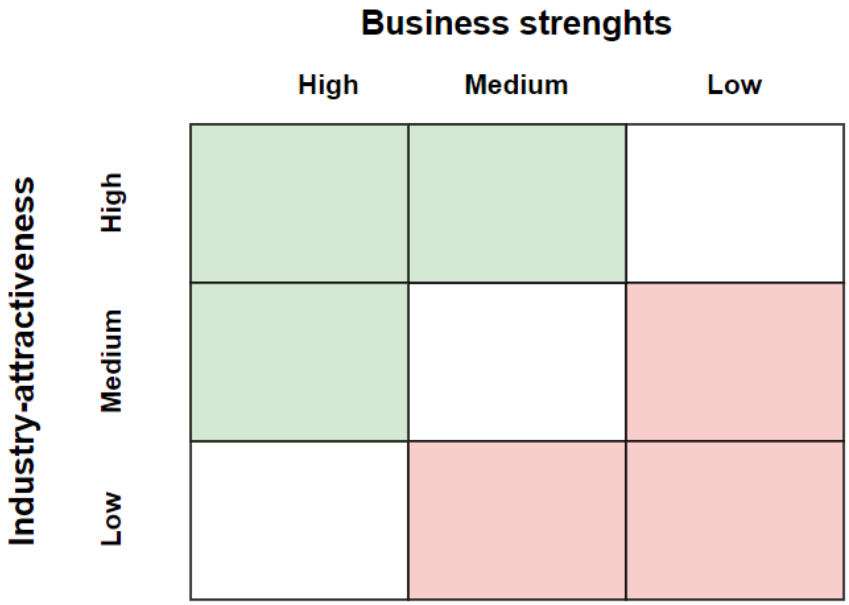

Figure 15. General Electric industry-attractiveness matrix (modified from Proctor & Hassard 1990)

Other mentioned portfolio planning matrixes Shell directional policy matrix and Arthur D. Little strategic condition matrix are other developed matrixes for portfolio analysis. Shell directional policy matrix maps company's competitive position and prospects for sector profitability in nine-cell grid (Hussey 1978; Robinson et al. 2001; Udo-Imeh et al. 2012). Arthur D. Little strategic condition matrix uses competitive position and industry lifecycle stage in this mapping (Udo-Imeh et al. 2012).

2.5 Synthesis of literature review

The first research question was: “How can product portfolio business analysis be conducted and what are the related attributes?” Product portfolio business analysis can be seen from different perspectives. As Kahn’s definition (2012) was that portfolio consist two parts, strategic and tactical part. This division links strategic part to organizations innovation, market, and technology strategy and tactical part to selecting right project and allocating funding and resources.

One way of doing portfolio business analysis is by using *product portfolio management (PPM) targets and key performance indicators (KPIs)*. PPM has both perspectives, strategic and tactical, as it focuses directly to portfolio. In general PPM targets are designed to lead PPM to right direction and used as a base for PPM KPIs. PPM KPIs are created to reflect PPM targets which are strategic alignment, maximizing the value of the portfolio, balance of projects, and right number of projects. PPM targets and KPIs should be also adjusted according to different product lifecycle phases and show when is time for renewal of product portfolio.

Business case analysis is other way of doing this analysis. Business case is important part of new product development process and it can focus on the tactical or strategic side of portfolio. With business case analysis organizations can evaluate and prioritize their projects and products and allocate resources more efficiently. Business case can also be used for product families or platforms and it links business case to innovation, market, and technology strategy. Business case is performed before products are approved for further development to ensure that products have good opportunity to succeed and meet the requirements that the organization have set for them. Business case analysis includes many steps, but those steps and attributes can be simplified to market assessment, technical assessment, financial analysis, and strategic fit. Analysis of business cases can be done with business case control which include evaluation and prioritization, monitoring and tracking of projects. With this method, organization can react quicker to changes in the environment and make decision about projects and products in the portfolio.

Portfolio analysis is another way of performing analysis of product portfolio. Portfolio analysis can be done with many different methods. Some of these methods use matrix for the analysis and the most popular one if these is Boston Consulting Group's Growth Share matrix. This matrix is 2x2 and it can be used to map product or even business units based on their market share and growth rate. These four areas in the matrix include stars, cash cows, dogs, and question marks. Another example of these methods is General Electric industry-attractiveness matrix. This matrix is 3x3 and it maps business unit by industry-attractiveness and business strength. These methods have both strategic and tactical side to them when mapping of products or product families show where resources and investments should be focused, and mapping business units can show which technology area or market deserves most attention.

When we focus more on the business analysis side of the portfolio, thesis includes two analysis areas *business ecosystem analysis* and *business model analysis.* Business ecosystem is formed from multiple different organizations that form network or chain that creates value in terms of offering and revenue. This value creation is boosted with sharing of capabilities, costs, and risks of product development. Well-functioning business ecosystem can be very beneficial to the actors of this ecosystem. Business ecosystems relate to portfolio business analysis when product development is developing some new technology area for the portfolio that could create a change in this business ecosystem. This change can mean new partners or changes in business models of actors inside the ecosystem.

Business model analysis is then needed when new product or technology create a need for new business model. Business model is representation of how organization creates and captures value. Main actors in business model are the organization, customers, and co-operators and elements that describe it are offering, revenue, resources, capabilities, and costs. By analyzing the current business model and its elements, organizations could increase their understanding of their stakeholders and find new opportunities. Sometimes when new product is created and added to portfolio, current busines model is not sufficient, and it would limit the value creation and capturing possibilities. In this situation new ways of value creation and capturing needs to be found by analyzing the current business model and creating a new one that captures the portfolio's value better.

Below (Figure 16) is collection of mentioned perspectives of portfolio business analysis, analysis attributes and related subject areas.

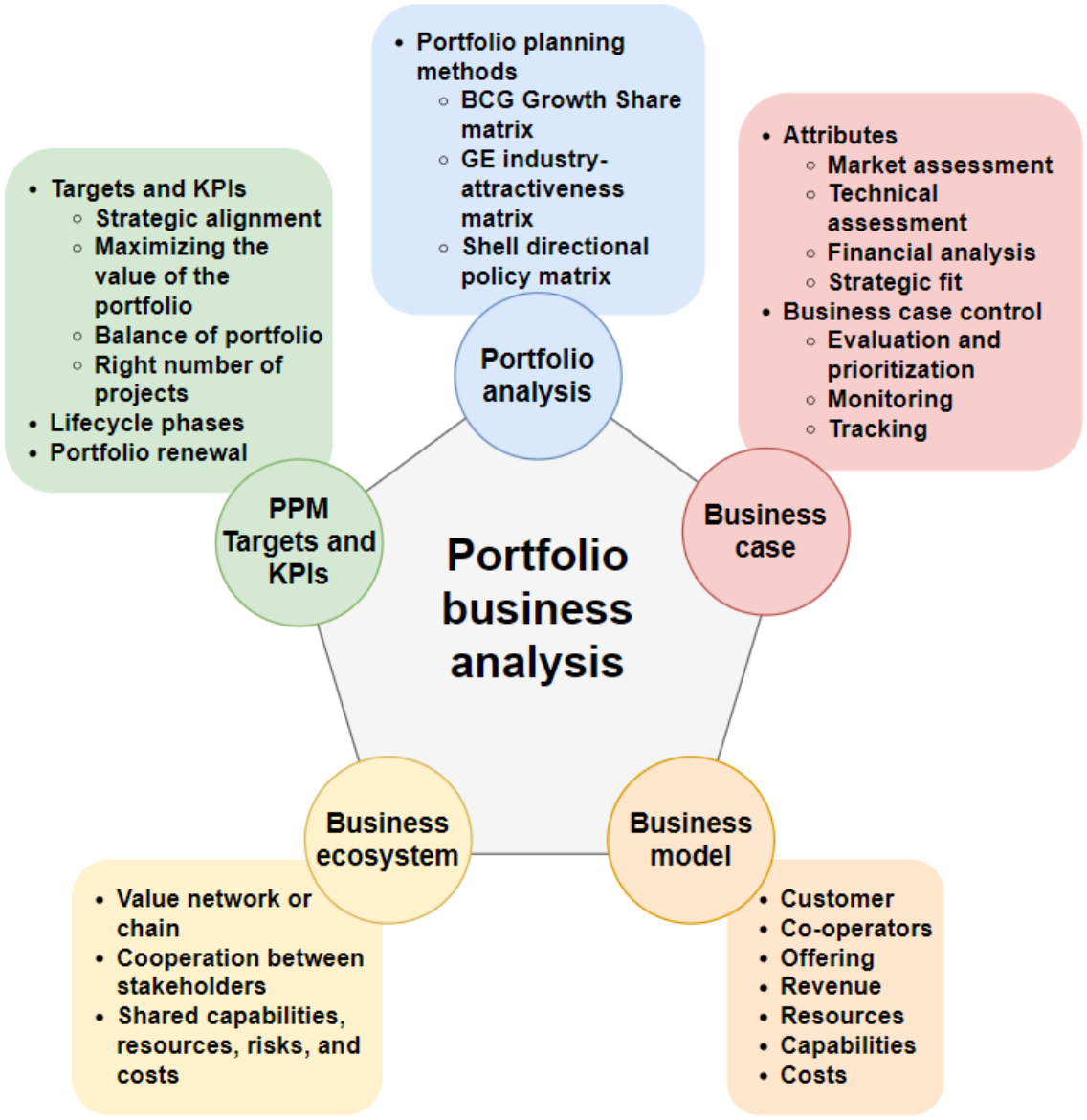

Figure 16. Collection of business analysis perspectives, analysis attributes and related subject areas

3 CURRENT STATE ANALYSIS OF THE CASE COMPANY

3.1 Research process

The case company is large international technology company. The case company has multiple business units and it provides complete solutions to customers that can include many complex hardware and software components and service solutions. This research is focused only on specific unit of the case company and the product portfolio is limited to specific product group. The goal of the current state analysis is to compare the findings from the literature review to current situation in the case company, find out possible problems related to thesis topic and confirm the initial problem statement for the thesis.

The material for current state analysis was collected mainly from case company's internal documents and through interviews and discussions with case company's employees. Some additional observations and thoughts are gotten through by being present in unit's weekly platform and product family planning sessions. Internal documents included Power Point presentations, Excel worksheets, Power BI reports, Intranet and SharePoint pages and training materials. Interviews were conducted as themed interviews. Discussion in the interviews were open but discussion themes and few main questions were provided for each interviewee (Appendix 1). There were 1-3 people with the same theme and questions, but most of the interviews had different themes. Most of the interviewees were from different job positions and different teams (Table 4) and there were total of 13 interviewees during the current state analysis. Interviewees were selected based on interviewee's job position and competence area that were closely related to the thesis topic. The most of these persons were suggested by thesis supervisors from case company's side but also few interviewees were suggested by other interviewees during or after the interview. So, snowball sampling was used for interviewee selection during the interviews, which means that interviewees were asked to name other possible interviewees for interviews, but this was not the main method for selecting the interviewees (Goodman 1961).

Table 4. Interviewees for current state analysis

Title	Number of interviewees
Product Manager	5
Portfolio Manager	2
Business Controller	1
Product Cost Manager	1
Total Cost of Ownership Manager	1
Competitiveness Manager	1
Team Leader, Platform Product Management	1
Platform Product Management Leader	1

The current state analysis started with case company's internal process and management guides about product, platform, and portfolio management. These gave the basic understanding about the processes in product and portfolio management and it was easy to compare these with the literature. Other internal documents were collected during and after the interviews. These documents included decision proposals for products and platforms, tools and calculations for business case analysis and platform and product family roadmaps. These decision proposals and business case calculations and tools showed what goes into making a business case and how business case is included to decision proposals with other decision attributes.

Current state analysis framework can be seen below (Figure 17). It shows which area from literature were used to compare with the current state of the case company. It also shows which materials were used for each current state analysis topic from the case company.

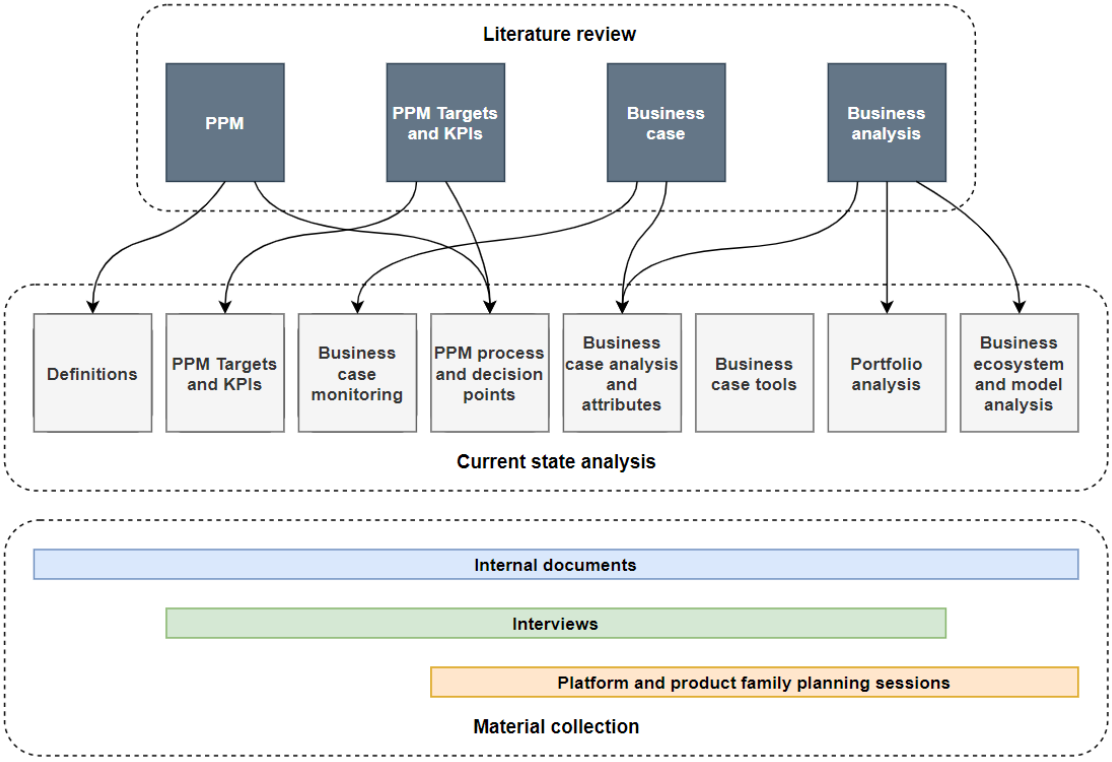

Figure 17. Current state analysis framework

3.2 Current product portfolio management practices

Case company has overall well thought processes and principles for product portfolio management (PPM). These processes and principles are also documented and stored in case company's intranet. Case company's PPM documentations include targets, principles, processes, sub-processes, activities, milestones, decision points and criteria, monitoring, and terms and definitions. The basic PPM principles include active strategy directed decision making about investments, priorities, portfolio additions and removals, lifecycle stages, and resource and investment allocations. Principles also include annual and monthly review, monitoring and reporting of performance, portfolio renewal and drive to maximize value, strategic fit and balance of the portfolio. The case company's organization has also unified definitions (Table 5) for different levels of products, systems, and portfolio items.

Table 5. Definitions

Term	Definition
Portfolio package	Business entity to cover certain case company market, containing portfolio items such as system, SW, HW and service products. Portfolio package has a business case.
Portfolio item	Product within a portfolio. In Product Data Management used to model the product classes, hierarchy, and relations
System	A system is a managed set of interacting products, e.g. applications and network entities, which are developed, sold, used and/or managed together.
System release	Defines released version of products as synchronized release.
Product	In case company a product is the smallest unit in portfolio management, for which a product master plan and business case is maintained., lifecycle management is conducted, and releases are developed. These properties of product apply to application, network entity, platform, system, service, and solution with the exception that solution has its own, different lifecycle management.
Product variant	Product variant is a parallel product content alternative which is developed in the product release.
Product release	A release is a version of a product with defined functionality that can be delivered to customers or used in, e.g. testing. Technically a release is a configuration baseline of a product that is released for a defined purpose.
Product module	SW, HW or combined HW and SW product modules. Part of a higher-level product structure, has own lifecycle.

3.2.1 Product portfolio management processes and decision points

Case company has different processes in for different levels of management. There is a process for portfolio and platform level management and a process for product level

management. In addition. there are processes for executing the product development process.

These processes are used for decision making, especially at the early stages of development process. Decisions are made to scope ideas, evaluate prospects, and decide which products and platforms end up in the portfolio. The product management process is focused to single product development process and decisions. It is used for product and opportunity evaluation before the actual development process starts.

The portfolio management process has been created over 10 years ago, but it has received some updates just recently. Earlier it was mainly used for decisions regarding one specific development unit's products. Now recently the focus has been moved more towards the platform driven process. Now decisions are more about what and how platforms should be developed and what kind of products and product families should be developed and sold from this platform.

These two processes have the maintain and ramp down phases but usually products are ramp down in their own process. Last steps of portfolio management process are used occasionally to bigger product family, platform or business exits from the portfolio, but these are not done before all of the individual products have been ramped down.

3.2.2 Product portfolio management key performance indicators and targets

The case company has defined product portfolio management (PPM) targets. These targets are defined in business unit level and apply to all units that it consists. The targets are:

- Maximize return of investment in changing and competitive business environment
- Ensure balanced and profitable product portfolio with growth potential
- Ensure investment capability and resources for sustainable business and for new opportunities

These three targets are well thought out and in line with the literature. Strategic alignment is only missing perspective from this target list, but it is discussed in the same document where product portfolio management principles are listed.

PPM key performance indicators (KPIs) are mostly done in higher business unit level. This higher level does not really follow specific products. They follow the overall performance from different perspectives like cost competitivness, sales, profitability, sales margins, operating expense (OPEX), comparisons between regions and markets.

In this unit, there are not many PPM KPIs. There are some KPIs related to competitiveness, cost savings, operating profits and how much certain product group is sold compared to others. These KPIs are in very high level and give very limited view of the unit's product portfolio's performance. In addition, there can be some ad hoc measures that are created for some specific analysis, but these KPIs are not usually permanent. This lack of good portfolio performance monitoring and KPIs is noticed in this unit, but currently is not on same level than the literature and would need some improvements.

One interviewee noted that one reason for this could be that this is unit that measures mostly how the product development processes are progressing and how it is performing overall. Other reason for lack of specific KPIs from interviews was the fact that the business environment and the technology is very complicated. The technology is changing faster, and faster and new technology platform are introduced in shorter and shorter cycles. One perfect analysis model would be hard to create, but something should still be done.

3.3 Current business case practices

Business case is one part of case company's product management and product development processes. Business cases for single products are performed during product management process. Single product business cases have been part of product management and product management process for longer time and the process of doing these business cases have been adopted by product management. The case company have also done some business cases for product platform and product families, but these business cases have not been so regular and the process of doing these business cases has not been fully in use. The case company has decided to start doing these business cases more regularly during portfolio management process. The process change has been made quite recently and it is still under piloting.

3.3.1 Business case analysis and attributes

As said, the case company has done single product business cases for some time. When doing these business cases there are lot of assessments and studies before the whole process is complete. Business case preparation includes technology feasibility studies, resource pipeline views, business reasoning, market and customer assessments, work effort estimations, risk assessment, operating expense (OPEX) and capital expenditures (CAPEX) calculations, product cost calculation and selling price and volume estimations. Output from these calculations is net present value (NPV), NPV percentage and break-even quantity.

NPV calculations are then one, but certainly not the only, factor in decision making about the products or platforms future. Other important factors are estimated volumes, how many customers product would have, customer commitments and prospects of customer deals. Already made customer deals and commitment or prospects of these customer deals are factors why business cases should be approved. Volumes and number of customers are then possible factors to reject the business case. These are critical especially if volumes are low or the product would have low number of customers. This situation increases the risk of losing the volumes which would make the business case of the product negative. In the other hand, if prospects are good, risk can be taken. As volumes are one of the most important decision factors, volumes are also the most inaccurate parameter in the business case. Especially, when development times are longer, volumes become harder to predict and almost all variation from the predicted result after business case approval is in the volumes. Other problem in these business case decisions were that the decision-making lacks visibility to R&D pipeline capabilities. This means that the realistic estimations of development times for products are hard to make in many cases. R&D gives these estimations to these decisions, but the schedule is sometimes very hard to predict. Other parameters, like development costs, product costs and investment amount, are usually fairly accurate.

There are also many cases where NPV or other calculations are not the deciding factor. Large share of the revenue for the case company comes from deals with whole solution including multiple hardware and software parts. This affects to business case decision making for example when one hardware part has bad business case by itself, but business case is justified as whole deal is positive. In these cases, there is usually very limited view

from this unit's business cases to the company level deals. This is not still seen as a big problem, but some product managers have felt that these single product business cases feel detached from the bigger picture. Those business cases do not show the end situation how they affect to the overall product portfolio situation.

Platform business cases have not been in use for long time and those have been done irregularly and the focus has been different. The case company wants and have decided to start doing more of those. Platform and product family business cases differ from single product business case usually with the time frame that those are planned. Single product business cases can be done with shorter time horizon, but platforms need to be planned far to the future. Platform business case still has same elements than single product business case, but calculations are much more inaccurate and mostly just estimations. As said in for single business case, volumes have the biggest variation in platform business cases. This variation increases in platform and product family business cases because those are planned even farther into the future. Also, many of the platform level business cases have been cost reduction or delta business cases. Analyzes have been focusing towards the technical side and how performance and value of the product could be maximized, and investments minimized.

Even though platform and product family business cases have been done to evaluate the idea and business opportunity, there has not really been chance to reject new platforms because it would have meant dropping out from this business sector. The technology has been advancing with so rapid pace that the new platforms have been must make situations. The questions have been just how and when. The case company wants to move towards more analytic process in platform and product family proposals. They want to compare what kind of products and product families should be developed and sold from the platform. Interviews showed that there is need for model with view on multiple scenarios about new platforms and product families and how that affect the situation with other platforms and product families.

3.3.2 Business case monitoring

The case company has some practices for business cases monitoring. The normal product or program management activities include updating the product business case during the product development process. These product business cases are updated by product

program when the product reaches specific milestone and the decision to continue the development is made. There is no continuous business case update by the product program, but one process has been started to follow these business cases more regularly. In this process, product business cases are monitored regularly with review meetings. If there are negative changes to business cases, it triggers inquiry to product program team. This way the reason for the change is investigated and possible decision can be made if needed.

Platform business cases do not have holistic follow-up process in place. The reason for this is mostly because the situation is followed with single product business cases. Other reason is that platform business cases and platform business case process are rather new.

3.3.3 Business case tools

The case company has good tool for single product business cases that is used by product managers when the official business case is made. This tool is easy to use and it does all the needed calculations and the end results are used in product decisions. This have allowed good data storing opportunities from these business case calculations and that has been the starting point for single product business case follow-ups.

Most of the platform and product business case calculations have been related to technical solutions and involved lot of calculations by hand. The single product business case tool has not provided very good possibility to model whole platforms or product families. Especially, affect to other product families and platforms have not been visible. There is need for improved tool for product platform and product family business case analysis that would also give view how these decisions would affect to other platforms and families.

3.4 Current portfolio business analysis practices

Other areas of portfolio business analysis did not really come up in the interviews because the focus was more on product portfolio management and business case analysis. Some of the elements of business environment and business model like joint development and co-operators, were still found from internal documents as well as heard in platform and product family planning sessions.

Business environment and business model elements came up in discussions about how new platforms should be developed technically. There were some options to go with full own development or few combinations of own development and externally developed parts. These options were evaluated, and business cases calculated. Then decisions were made based on these analyses and calculations.

These elements could also be found from business case analyses and product and platform proposals. These proposals included partner and supplier parts, where suppliers and partners were evaluated and selected. Proposals also included portfolio analysis elements. These were for example statements about product group's growth and market potential, evaluation and comparison of product segments and how case company's strength and capabilities compare to others in this sector.

3.5 Current state synthesis

When looking the situation in the case company after the current state analysis, the overall situation is good. Product portfolio management (PPM) practices like, targets, processes and decision point and criteria, are in place and used in the organization. Same can be said about single product business cases. There is a single product business case process, attributes, and a follow-up process in place. Also, platform and product family business cases had received more attention just recently and there is process for that. There are also some visible elements from portfolio analyses and business ecosystem and business model analyses in the analyses and decision making.

Even though the overall situation is good, there are some, mostly already identified, problems that came up during the current state analysis. One of the main problems was that these platform and product family business cases do not really show how the overall portfolio situation is affected by those decisions. These decisions would need more visibility to how these decisions affect to the other platforms and product families. These were also lack of easy way of making different scenarios about those upcoming platforms and product families. Current scenarios are made by hand and take long time to make and calculate. This leads to situation that all the possible scenarios cannot be made, and decision possibilities are limited.

The other main problem related to the thesis topic was unit's very limited PPM key performance indicators (KPIs). The unit do not really have wide product portfolio monitoring process. Followed KPIs are limited to just competitiveness, cost savings, operating profits and how much certain product group is sold compared to others. These KPIs are followed in high level and there is no real monitoring of product families or platforms compared to each other with multiple KPIs. The interviews showed that need and want for this kind of more detailed and analytic view is present, but there have not been any actions yet. This kind of overall view could help for the mentioned problem that single product business cases feel detached from the overall picture.

Other problems that came up during the interviews were volume forecast inaccuracy and lack of real time visibility to R&D pipeline. The volume forecast inaccuracy came up during interviews when business case and decision-making attributes were discussed, and it is big factor in reliability of business cases. This problem was identified by many of the interviewees. There have some actions to by the case company to improve this situation, but the complete solution has not been found yet. Few interviewees mentioned that decision making lacks in visibility to R&D pipeline capabilities. The capability situation is not updated in real time and in some cases the timeline for some development process could be just very inaccurate estimate. This can affect how the case company can plan product in the long term.

Below you can see the main problem of the case company and collection of other found problems from the current state analysis (Figure 18).

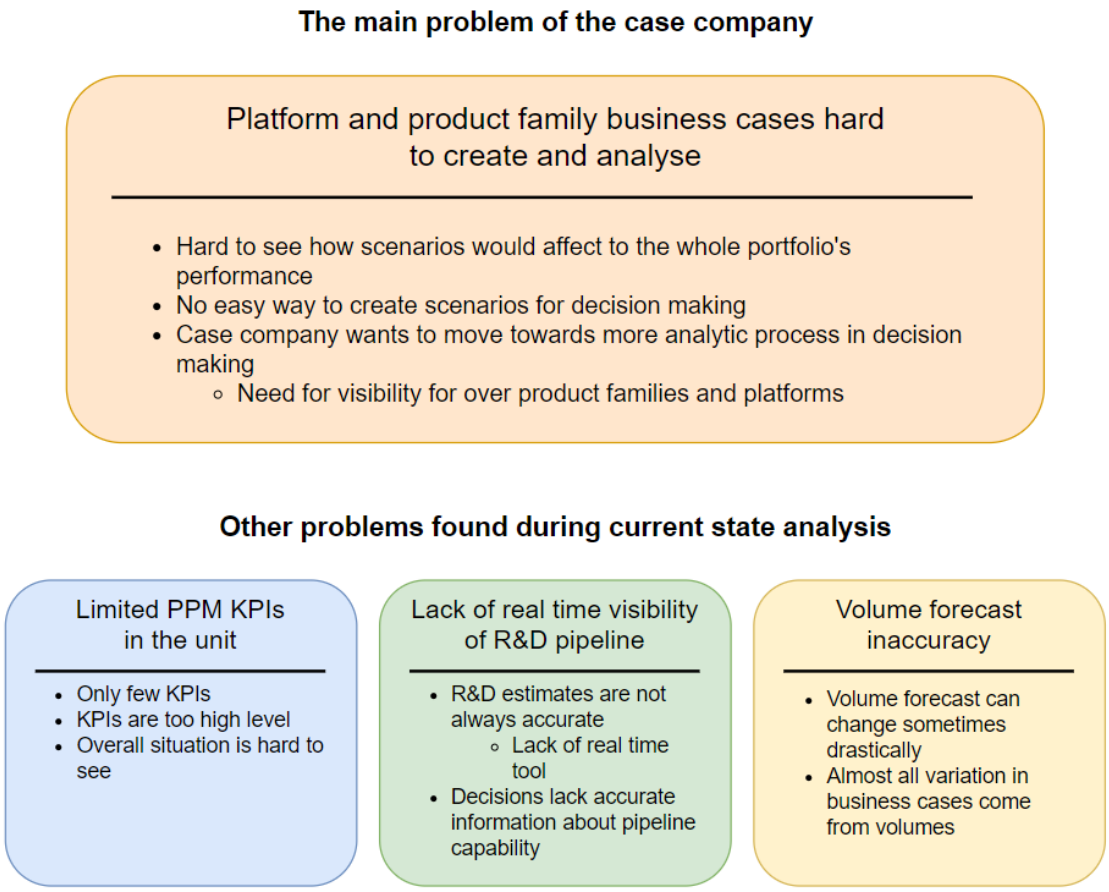

Figure 18. Main problem of the case company and other problems found during current state analysis

4 BUILDING THE FRAMEWORK FOR THE CASE COMPANY

The main problem behind this thesis was that the case company did not have any good framework for product portfolio decisions. Decisions are made reactively one at a time, but there is no real visibility to how these decisions affect to other product groups or families in the product portfolio. To solve this problem, this chapter proposes portfolio business analysis framework.

As the concept of portfolio business analysis was not found in the literature, this framework in created by analyzing different related discussions from the literature. These discussed topics by themselves are not enough to understand the bigger picture of the portfolio, so these topics and their attributes were combined to create portfolio business analysis process model.

The framework was created based on the topics in literature, but it was modified in co-operation with the case company to fit it to their needs and processes. In addition to this, part of this framework is implemented to the case company as part of the thesis.

4.1 Portfolio business analysis framework

The proposed portfolio business analysis framework (Figure 19) is a high-level presentation of portfolio business analysis process and attributes. This process is not a linear one-time process, but more like continuous iterative process where process steps can be done simultaneously, and information is updated constantly. This analysis process starts with input. These inputs can be some changes in the market like customer needs, prices of products, costs of components, technology development or new products in the industry. The input can also be from inside the organization like new product or technology idea. These inputs are then the starting point for new round of portfolio business analysis.

The portfolio business analysis starts with high-level business model and business ecosystem analysis. In this analysis organization’s offering, suppliers, value chain or revenue model are evaluated and analyze if changes are needed. This is done because,

some bigger changes in the market or completely new technology can change the business model or even the whole business ecosystem around an organization. When the at least high-level understanding of possible needed changes or additions to offering, supplier, value chain or revenue model is created, process can move to portfolio analysis.

Portfolio analysis is part where product portfolio is analyzed with new inputs. In portfolio analysis products, product groups, families, platforms, and generations can be compared to each other with different key performance indicators (KPIs). This comparison is done to understand the effects of the change that was the input for the process. The KPIs for these comparisons should be based on product portfolio management (PPM) targets and KPIs. When product portfolio is analyzed with PPM KPIs, analysis can give clearer picture how these changes can affect to the whole portfolio over the product families, platforms, and generations. When the effects on portfolio are clear and if it seems that the change should be done, process can move to business case analysis.

In business case analysis, organization can analyze the change with more accuracy. Business case analysis includes market assessments, technical assessments, and financial analysis. These assessments are done to get deeper and wider understanding of the effects of the change and organization can see more accurate financial outcomes. If outcomes are good, business case should be turned to decision proposal. If business case does not seem good, process can go back and rethink the idea.

Decision proposal is the possible output of the portfolio business analysis. With decision proposal the organization can make informed decision and approve or reject the change. If the proposal is approved, organization can move to implement the change into the product portfolio.

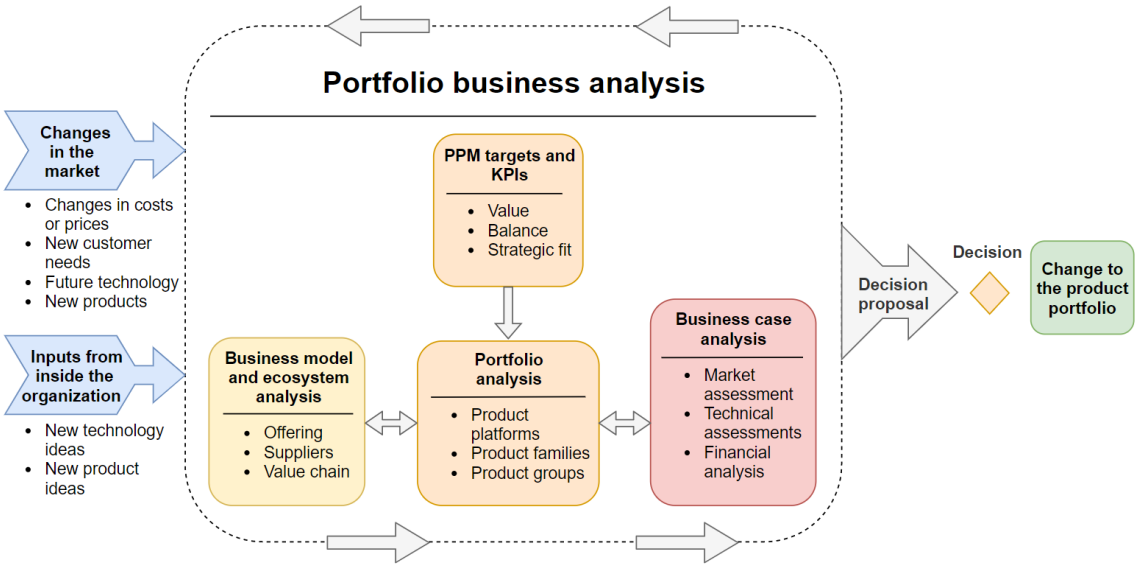

Figure 19. Portfolio business analysis framework

4.2 Business model and ecosystem analysis

Business model and ecosystem analysis is the starting point of the analysis. After new inputs, like change in the market, are identified, organization should do at least a high-level analysis on their business model and ecosystem attributes, like offering, suppliers, and value chain.

Analysis of the offering means that organization analyzes if the change in the market is so big that this organizations should develop new products, ramp down products, or even attack to new business sector. Inputs that could cause that could be for example ricing of component prices. This could affect profitability of some products. Input could be emerging new business sector from new technology that the organization needs to attack to stay competitive. Same kind of analysis could be done to customers, where organization analyzes if this change or new product needs new customers or the affects to relationships or planned deals with current customers.

Business model should be also analyzed in terms of value creation. Changes in the market, prices or costs, new need from the customers, new product idea, or completely new technology can create need to change the value chain of the organization. In these cases,

organization needs to rethink their business and come up with new ways to create value for the customers and bring revenue for the organization.

If the market change or new product or technology idea is so impactful, it can cause change even to the business ecosystem. This kind of change can require new players to the surrounding business ecosystem like new suppliers or co-operators. For example, some product ideas can require new outside knowledge or resources or changing pricing from supplier can start new supplier selection. There are many things that can trigger business model or business ecosystem analyses. After there is at least high-level understanding of where this change or new product affects, organization can move to analyze the product portfolio with business model and ecosystem analysis as a base.

4.3 Portfolio analysis based on PPM targets and KPIs

Portfolio analysis is second part of portfolio business analysis. The idea of the portfolio analysis is to compare products, product families, product groups, product platforms, and product generations to each other. This part of the analysis can use results from business model and ecosystem analysis or original inputs from the outside of the process as a starting point. Portfolio analysis could also trigger business model or ecosystem analysis if portfolio analysis results require that.

Portfolio analysis can be done with many different parameters and levels. For example, analysis can be done to product generations' profitability after increase in costs, product groups' sales after new competitor enters to the business or product families' growth rate in new business sector. With these kinds of analyses, organization can see the differences between different product groups and families and understand what they need to do if the situation has changed negatively. For example, if product groups sales have dropped due to new competitor, organization needs to understand how it affects to prices, costs, and profitability etc. Then organization can decide how they need to respond to this situation.

When doing these analyses on products, product families etc. in portfolio analysis, these comparisons should be done based on good KPIs. If organization already has good PPM targets and KPIs, those should be used to get results that are easy to compare with current situation. Also, analysis is much quicker if organization do not have to create new KPIs

or start to collect relevant data. If organization do not have suitable PPM targets and KPIs, these should be created, because those are the base for understanding the portfolio's current situation and how product perform.

Good PPM KPIs are set to reflect organizations PPM targets. PPM targets are ones that include organization's strategy, portfolio's value, and portfolio's balance. Strategic fit PPM KPIs can be for example, product portfolio aligned with strategy, number of resources in product development, and value of strategic investments for R&D. KPIs that tell about portfolio value are for example, net present value, return on investment, gross margin and cost of goods sold. PPM KPIs should also include portfolios balance with KPIs like, size of the portfolio, number of products, and balance of resources, high-risk and low-risk, long-term and short-term, technology, and markets.

4.4 Business case analysis

Business case analysis is the possible last part of the portfolio business analysis. If portfolio analysis results show that there could be need for change in the product portfolio, business case analysis for the change can be then performed. Parts of business case analysis can be done during other process phases and last adjustments made after portfolio analysis results are ready.

In business case analysis, there are three main tasks: market assessment, technical assessment, and financial analysis. The market assessment includes for example assessments for customer needs, value, and requirements, opportunity window, target market, and market growth and potential. Technical assessment includes for example technical complexity, uncertainty, and risks, availability of resources, work effort estimates, and manufacturability. Market assessment analyses that would the market accept this change and it is used for base to determine how much sales this change could bring. Technical assessment analyses the other side, could the organization deliver this and when and it is used to calculate how much it would cost. After these two stages, financial analysis combined these two sides and calculates for example price and sales estimations, cost estimations, payback levels and cash flow statements.

With this kind of business case analysis, the organization can perform a deeper analysis about the effects of possible change to the portfolio. For example, analysis could show how introduction of new product groups would affect the market, how much sales it could bring, and how much it would cost. In the end organization can see of the new product group introduction would be beneficial according to their analyses. If the results of business case analysis are desirable, the results should be turned into decision proposal. This proposal should be then presented to decision maker who decides if this change is accepted or rejected. If business case results show that this change should not be even proposed to decision maker, process can go backwards to earlier phases and for example do the portfolio analysis again.

4.5 Practical implementation for the case company

In addition to developed portfolio business analysis framework, there was also practical implementation of this framework to the case company as part of the thesis. The practical implementation was planned based the original problem statement and interviews during current state analysis. The practical implementation for the case company focused mostly on portfolio analysis (Figure 20). There were also some PPM target and KPI and business case analysis elements. The Business model and ecosystem analysis was decided to be excluded from this implementation during the thesis. This was done to ensure that there is enough time to do the implementation and bigger implementation would have required deeper research and analysis.

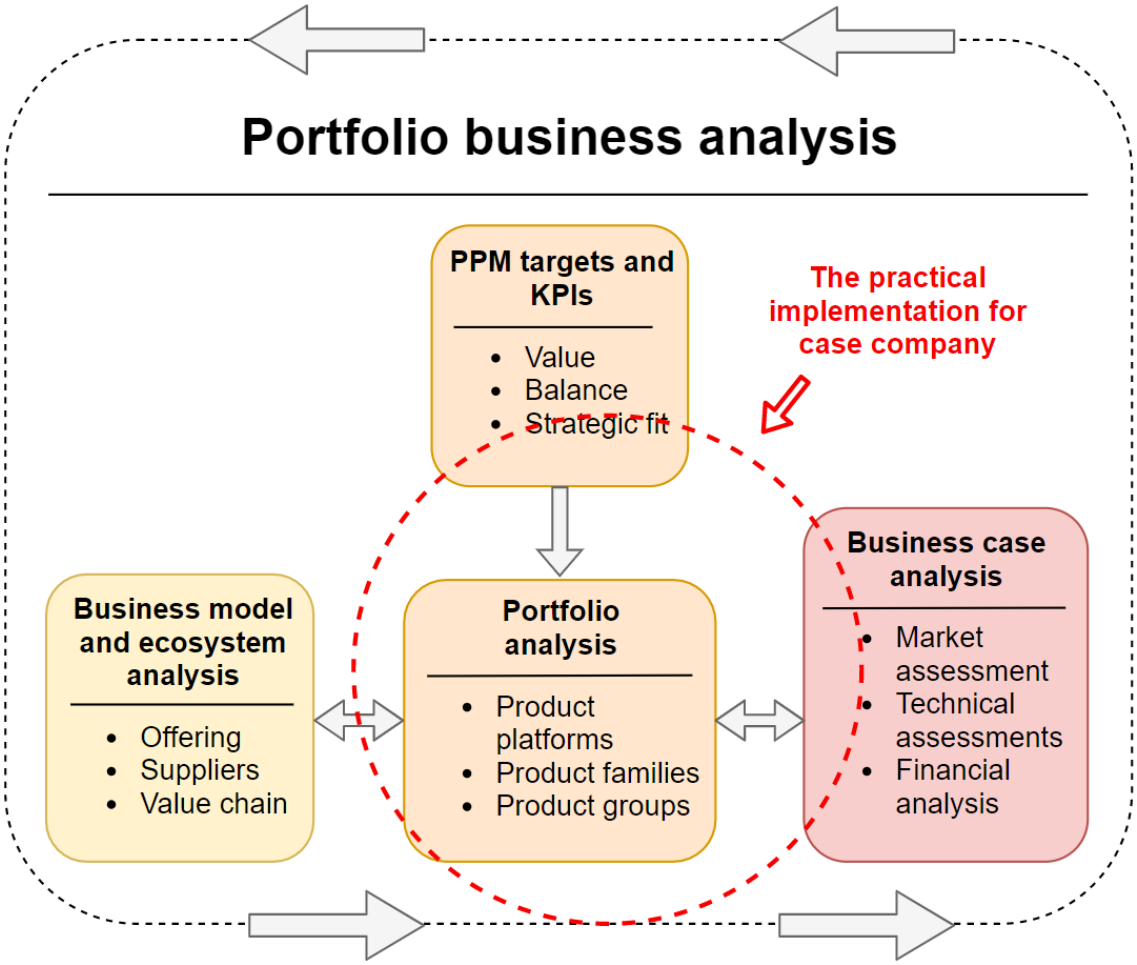

Figure 20. Practical implementation for the case company

The practical implementation that was created is a portfolio analysis tool that can be used to create several scenarios about the future and the state of product portfolio. In this tool product platforms, product families and product groups can be compared and planned with different parameters. This means that the future portfolio's product platforms, families and groups can be planned for example with different sets of products. These planned scenarios can be then compared easily to the original plan. This gives a possibility to create multiple different scenarios easily and quickly that give the results right away. These scenarios parameters and results can be then the base for the deeper business case analysis and possible decision proposal.

As the case company did not really have PPM KPIs for this specific DU's product portfolio, few KPIs had to be created to be able to compare those scenarios. These KPIs were created based on the available data in data base. Created KPIs show the financial

effects of the scenarios and allow quick look if change in the possible scenario is profitable.

The practical implementation planning started already at the start of the thesis when the case company introduced the topic and related areas. The vision of the end result became clear during the current state analysis when good data related to the problem area was found already in case company's data base. After current state analysis, planning meetings about the planned tool and meetings about the base data from the data base were held. After these meetings the tool was created to Excel and it utilizes automatic data updated from the data base.

4.6 Evaluation of the framework

As mentioned in Kasanen et al. (1993) article, to prove managerial construction's usefulness, practical test needs to be performed. Practical test chosen in this thesis was weak market test. Weak market test means that manager who is responsible for financial results is willing to use the construction in decision making (Kasanen et al. 1993). Due to the focus on one unit and time limitations of the thesis, strong or semi-strong market tests are not performed. To pass strong or semi-strong market test, the construction would have to perform systematically better financial results in the business unit or that the construction would be widely adopted in the case company (Kasanen et al. 1993).

The weak market test for the developed tool was performed with five-person team responsible of unit's product portfolio decisions. The test was performed in one-hour long market test meeting. During this meeting the tool was firstly introduced to the team. Presentation included where and how the data was collected, how the data is analyzed, what input tool users need to give, how the scenarios are created and what kind of results the tool would give. The team members asked questions about the tool during and after the presentation, so that the team would get good understanding about the tool and how it works.

After the presentation and the questions, the team got evaluation form to fill. In this form, there was 10 questions to answer. The first 8 questions were part of general evaluation of

the tool and answer option was range from 1-5. Results of these 8 questions are below in table 6.

Table 6. Questions in weak market test (1 = Very bad/hard, 2 = Bad/hard, 3 = Average, 4 = Well/easy, and 5 = Very well/easy)

QUESTION	RATING
How well can the tool perform product portfolio analysis?	4,6
How well can the tool create different scenarios?	4,4
How good of a picture do the KPIs created in the tool give of the scenario and their differences?	4,2
How good basis do the results of the tool provide for a more accurate business case analysis?	4,6
How good is the reliability of the tool's results?	4,2
How good is the reliability of the data used in the tool?	3,2
How easy is the tool to use?	3,8
How well does the tool meet the expectations placed on it?	4,8

From these results on first two questions we can see that the tool got good points from product portfolio analysis and its scenarios with 4,6 and 4,4 averages. The score of 4,3 in question 3 shows that the tool also has good KPIs that can give good view on scenarios and their differences. Results also show that tool gives good base for deeper business case analysis about the possible change in product portfolio.

Reliability of the tools result's seen to be on good level as the score is 4,2, but there are some doubts of the reliability of the data used in the tool as the score drops to 3,2. This score is understandable because there were some flaws in the data that was gotten from the data base. Tool was rated to be moderately easy to use with score of 3,8. The slightly

lower score in this question might be due to amount of manually added data that the tool needs to be able to calculate results farther to the future.

At the bottom of the table 6, question 8 show that even though there were some questions with average score below 4, the tool over all met the expectation, that team had, very well. The 9th question in the questionnaire was “Will the tool be taken as a part of product portfolio decision making?”. All of the respondents answered “Yes”, so the tool passed the weak market test. The last question of the questionnaire was “What suggestions for improvements would you give to the presented scenario tool for the future?” This question was optional, and three respondents answered to this one. Most of these comments were little additions to result KPIs and few additional scenario possibilities.

5 CONCLUSIONS

5.1 Key results

The main purpose of this thesis was to create new portfolio business analysis framework that could help the case company to do more accurate analysis of their product portfolio and help product portfolio decision making. To achieve this goal, three research questions were formed to get the wide picture of research topic and guide the research towards the goals.

The first research question was “How can product portfolio business analysis be conducted and what are the related attributes?” To be able to answer this question, literature review was conducted in the chapter two of the thesis. The literature review showed that there was no such term like “Portfolio business analysis” in the literature, so the chapter focused more on related topic areas. The literature wide range of knowledge about product portfolio management (PPM) and its targets and key performance indicators (KPIs). By focusing the PPM targets towards company’s strategic targets, maximization of product portfolio’s value, and balance of the product portfolio, and by creating PPM KPIs that really reflect and measure those targets, the product portfolio could reach its full potential. Literature also included a lot of knowledge about business case analysis. Business case analysis is one way of systematically analyzing new product additions and changes to product portfolio. Business case analysis should include market and technical assessments and financial and strategic fit analyses. Other related analysis areas found from the literature were portfolio analysis, business model analysis and business ecosystem analysis. Portfolio analysis can be conducted by mapping products or product groups with different variables like growth percent, market potential, sales numbers etc. With this kind of analysis, organizations can easily present which product and product groups are bringing the most money and have the biggest potential. Business model and ecosystem analyses focus more on the business side of the product portfolio. These analyses are in question when there is new big product or technology changes in the market or organization. With business model analysis, organization can evaluate what kind of offering and value chain the organization needs after these changes. Business ecosystem analysis tells more about what kind of co-operators and suppliers the organization needs to the able to do these bigger product portfolio changes.

The second research question was “What is the current state of product portfolio business analysis in the case company? What are possible challenges?” To answer this question, the chapter three describes current state analysis performed in the case company. This current state analysis showed that the case company has good processes in place for single product business case analysis. The case company does these single product business cases systematically to every product and has been doing this for some time. Business cases for bigger entities like product families and product platforms are not so well implemented in the case company. This has already been identified in the case company and there have been actions to start these analyses and product platform business case analyses have been performed few times. But the process lacks a good way of analyzing the effects of the change over other product platforms and families. Other identified problems from the current state analysis were lack of PPM KPIs in the specific unit in question in this thesis and lack of clear visibility to R&D resource pipeline. The unit in question had very few PPM KPIs to track their product portfolio and its performance. The few KPIs that they had were very broad and high-level KPIs that did not really tell how the products or platforms compare to each other. The problem with visibility on R&D resource pipeline came up during interview while discussing about things that affect business case decisions.

The third research question was “How to build product portfolio business analysis framework for decision making?” This question was answered in chapter four with portfolio business analysis framework that can be found in figure 19. This framework was created based on literature review and discussed problems in current state analysis. Even though the framework included inputs that start the analysis process, the process itself is not just linear onetime process. The process includes business model and ecosystem analysis, portfolio analysis with PPM targets and KPIs, and business case analysis. These steps can be performed partly simultaneously, and process can also move backwards. The idea of this process is that some input from the market or from the inside of the organization, like changing costs, customer needs, new technology or new products, start the portfolio business analysis process. Then the first step is business model and ecosystem analysis and it means that the effects of the inputs are analyzed in this context. This could be for example analyze of offering, if change in prices or costs affect to the profitability of the products. It could be analyzing of co-operators and suppliers if the organization need new ecosystem around them to develop a new technology. The analyze

could be done also to the value chain if new customer need or new technology require new ways of value creation. Next step of the process is portfolio analysis with PPM KPIs. In this part the effects of the change are analyzed in product portfolio. With this analysis, the organization can see how the change effect different levels of the portfolio and analyze if the portfolio needs changes. The analysis should be done with existing PPM KPIs so that the results are easy to compare with historical data about the portfolio. The last part of the process is business case analysis. In this part, the possible changes to the product portfolio are analyzed deeper. These analyses include market assessment, technical assessment, and financial analysis. Based on these analyses the organization can make the decision proposal and decide of this change will be made.

5.2 Theoretical contribution

The literature has wide range of knowledge about PPM, PPM targets and KPIs, and business case analysis. Portfolio analysis techniques are also known for long time in the literature. There are also studies, like Kinnunen et al. (2013), that connect business model analysis and business ecosystem analysis to product development process. This study proposes new framework for portfolio business analysis by combining topics from the literature.

By combining different aspects from the literature, the framework gives wider view on portfolio business analysis. This wider view gives literature new viewpoint on portfolio's business analysis and give good indication what aspects need to be taken into consideration when analyzing product portfolios.

5.3 Managerial implications

As described earlier, the main problem with portfolio analysis in the case company was that the product portfolio decisions were made with reactive single product business cases. These decisions did not include analyses of the affects that these changes would have to the rest of the portfolio's performance. This study provides new framework for conducting portfolio business analysis in organizations that will help the analysis and decision making. This framework shows how the company should view these portfolio

analyses and decisions. Company can utilize the framework by adding new areas to the analyze process before product portfolio decisions.

During this thesis, part of this framework was already partly implemented to the case company. This implementation was product portfolio scenario analysis tools that was created to Excel. With this tool the company gets a good starting point for portfolio business analysis and can move toward more analytical portfolio decisions. This tool was created and tested during the thesis. The tool will be utilized in decision making, so it passed the weak market test. The next steps for the company are that this tool needs to have primary user, who has the best knowledge of the tool and can operate it well. This approach is necessary because the tool will be used by a small team. There should be one person responsible for the keep up of the tool so that there are no mix ups. The data need to be kept up to date for other user, so that every user gets the same version of the tool and same data. Also, the tool needs to be secured from users from outside of the team due to sensitive data used in the tool. After these steps the company can start utilizing the tool for portfolio analysis when doing product portfolio decisions.

5.4 Evaluation

This research used constructive approach to the problem because the topic's nature was complex. Also, the results were expected to give new developed method for case company's real-life problem. To evaluate this research's reliability and validity, Lincoln's and Guba's (1985) framework were used. This framework uses concept of trustworthiness to evaluate reliability and validity of qualitative studies. The concept covers credibility, transferability, dependability, and confirmability (Lincoln and Guba 1985).

Credibility of the research mean how believable the results of the research are (Lincoln and Guba 1985). The credibility of the research is considered by gathering the data from different sources. Data was collected from interviews, internal documents, and intranet pages. Document were also linked by multiple different persons so that the data would not be bias, and it would represent the whole unit as well as possible to get believable results. The results of the research were discussed with case company's representatives to correct any flaws.

Transferability describes how well the results of the research can be used in another context (Lincoln and Guba 1985). This is can be hard in qualitative studies that are done in specific environment or company. Also, problems in qualitative studies are often very complex. This research falls in this category very well, as the scope of the research is one unit in one company with complex problem. The study method used in the research is repeatable in different contexts and organizations and it enables research of similar issues but the results in different context's probably are not identical due to different practices, personnel, and environment. Even though the problem is complex and in specific environment, the study presents generalized framework for product portfolio business analysis without too much company specific modifications. This framework could be used in other environments and organizations with some modifications, but the framework would need more studies in different environments and organizations to be proved useful.

Dependability refers to repeatability of the research (Lincoln and Guba 1985). This means that if the research would be done in different time by other researcher, the results would be similar. This aspect is generally hard in qualitative studies. The studied environment will most probably change during time and even if same job positions for interviewees would be used, the persons could be different with new and different views of the topic. Especially the found problems are most likely different in different times. Repeatability was considered in this study by making questionnaire for the interviews, but questionnaire was not fully used in every interview because interviews were open themed interviews and parts on the questionnaire were used based on interviewees competence area. Interviews were also recorded, and research process documented.

Confirmability considers how objective the researcher is during the research (Lincoln and Guba 1985). The objectivity of the researcher in this study could be affected by the study background in field and earlier work background with the case company. During this research, the researcher has been as objective as possible. This means that multiple perspectives have been studied and data was gathered from many different sources and persons. The analysis and conclusions have been made as objective as possible.

5.5 Further research

The agreed product group limited the focus area of the thesis to case company's specific unit. This unit manages only one part of the company's whole product portfolio. This new developed framework and product portfolio scenario analysis tool could be also studied in other unit's and even with the whole product portfolio of the case company. Also, it would be interesting to test this framework with company form different industry and see how it would fit there.

During the current state analysis, it was identified that this unit does not really have many PPM KPIs. It would be beneficial to continue from the base that the scenario tool created and start creating more KPIs that could show more detailed view of the current situation and the predicted future of the product portfolio. Also, the better view for the R&D resource pipeline would be important thing to study because it has big impact on portfolio decisions and how the product development can stay in the schedule that is planned when the decision are made.

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Appendix 1: Interview themes and main questions

Interview themes and main questions

- Product portfolio management
    - Processes
        - Products
            - What kind of processes do you have for managing products?
        - Platforms
            - What kind of processes do you have for managing platforms?
        - Decision points
            - What decision points do you have in these processes?
            - What kind of requirements and criteria these decision points have?
    - Product portfolio management targets and key performance indicators
        - Targets
            - What are the targets of the product portfolio management?
        - Key performance indicators (KPIS)
            - What KPIs do you use in product portfolio management?
            - How often these KPIs are followed?
- Business cases
    - Processes
        - Products
            - When business case is created for products?
            - What is needed before business case can be created?
        - Platform
            - When business case is created for platforms?
            - What is needed before business case can be created?
    - Attributes
            - What kind attributes product business cases have?
            - What kind attributes platforms business cases have?

    - Decision points
        - Requirements and criteria
            - What kind of requirements and criteria do you have for accepting the business case?
    - Tools
            - What kind of tools you have for business case creation?
            - What kind of tools you use for analyzing the business cases?

- Use cases
            - Could you give some examples?

- Challenges related to topics
            - What are the main challenges related to product portfolio management?
            - What are the main challenges related to business cases?

- Suggestions for product portfolio level business analysis framework?